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Via U.S. Mail and Facsimile

March 24, 1998

Cal/EPA

Department of Toxic Substances Control

245 West Broadway, Suite 350
Long Beach, CA 90802-4444

115

Mr. S. Mario Stavale
Boeing Realty Corporation
4060 Lakewood Blvd., 6th Floor
Long Beach, California 90808-1700

Dear Mr. Stavale:

REVISED POST-DEMOLITION RISK ASSESSMENT, BOEING C-6 FACILITY, PARCEL A, LOS ANGELES, CALIFORNIA

The Department of Toxic Substances Control (DTSC) has completed review of the document *Post-Remediation Risk Assessment, Boeing C-6 Facility, Parcel A, Los Angeles, California*, dated March 6, 1998, and received by DTSC on March 9, 1998. Our review has determined that the *Post-Remediation Risk Assessment* has been adequately revised to address the comments contained in our February 26, 1998 letter. The enclosed comments from Deborah Oudiz of the DTSC Human and Ecological Risk Division (HERD), dated March 25, 1998, provide further details of DTSC's review.

DTSC hereby approves the *Post-Remediation Risk Assessment* with the following conditions:

(1) The exposure scenarios in the *Post-Remediation Risk Assessment* are based upon a deed restriction for this property. Therefore, a deed restriction limiting future development to light commercial/industrial use must be instituted by Boeing. In addition, the deed restriction must prohibit the development of domestic or production wells on the property.

(2) The three arsenic impacted areas must be excavated to background concentrations and the material sent off site. Boeing must perform confirmation sampling of these three areas after remediation and provide the results to DTSC and the Los Angeles Regional Water Quality Control Board to substantiate the finding of this risk assessment.

Also, I would like to advise you that DTSC will be relocating to the City of Cypress effective March 30,

1998. Our new address will be 5796 Corporate Avenue, Cypress, California 90630. My new telephone number in Cypress will be (714) 484-5423.

If you have any questions, please contact me this week at (562) 590-4944 or at (714) 484-5423 after March 30.

Sincerely,

Karen Baker

Karen Baker, Unit Chief
Southern California
Permitting Branch

Enclosure

cc: Dr. Deborah Oudiz
Human and Ecological Risk Division
Department of Toxic Substances Control
P.O. Box 806
Sacramento, California 95812-0806

Mr. Michael Young
Integrated Environmental Services, Inc.
3990 Westerly Place, Suite 210
Newport Beach, California 92660

Mr. Jim Ross
Regional Water Quality Control Board - Los Angeles Region
101 Centre Plaza Drive
Monterey Park, California 91754-7500

Cal/EPA

Department of Toxic Substances Control

400 P Street, 4th Floor
P.O. Box 806
Sacramento, CA 95812-0806

MEMORANDUM

Pete Wilson
Governor

James M. Strock
Secretary for Environmental Protection

TO: Karen Baker
Supervising Geologist
Hazardous Waste Management Branch
Southern California Region
5796 Corporate Ave.
Cypress, California 90630

FROM: Deborah Oudiz, Ph.D.
Senior Toxicologist
Human and Ecological Risk Division

DATE: March 25, 1998

SUBJECT: McDonnell Douglas (Boeing): Revised Post-Demolition Risk Assessment, PCA 24120 Site Code 400627/50 MPC 44

The Human and Ecological Risk Division (HERD) was requested by you to review the revised Post-Demolition Risk Assessment for Parcel A on the former McDonnell Douglas site in Los Angeles. This document has been revised in response to HERD comments (February 26, 1998) on the draft Post Demolition Risk Assessment (February 12, 1998). The background for this site and regulatory responsibilities were discussed in the memorandum from Dr. Deborah Oudiz (February 26, 1998). The concerns raised in this memorandum were discussed via conference call with Karen Baker, Deborah Oudiz and Integrated Environmental Services on February 27, 1998 and all issues were satisfactorily resolved. The current document incorporates these specified changes.

Document Reviewed

Post-Demolition Risk Assessment Boeing Realty Corporation, C-6 Facility, Parcel A, Los Angeles, California, March 6, 1998.

Post-Demolition Risk Assessment Boeing Realty Corporation, C-6 Facility, Parcel A, Los Angeles, California, Supplemental Data, Books 1-5, March 6, 1998. Prepared by: Integrated Environmental Services, Newport Beach, California.

Comments

All of the outstanding issues were adequately addressed in the revised Post-Demolition Risk Assessment and the document is acceptable to HERD/DTSC without further revisions. The Risk Assessment was conducted assuming that the arsenic hits which were above background in AOCP 2 will be excavated to background levels. DTSC/HERD will receive an addendum to the Risk Assessment with the verification sampling for these isolated areas.

The risks for the future onsite receptors, the commercial/industrial worker exposure scenarios, were calculated in two ways. First, the risks were assessed assuming no direct soil contact due to a layer of clean soil on the site, and, second, direct soil exposure pathways (ingestion and dermal exposures) were included in the evaluation, assuming that the workers could be exposed to subsurface soils. The second analysis was consistent with the standard commercial/industrial exposure scenario which HERD has required on a number of sites throughout the state. The risks presented in Table 6-3 should be interpreted to represent the range of risks for commercial/industrial activities on the site from residual soil contamination. These risks fall within a range of values that HERD has historically determined to not present a significant health risk for future occupants. It is also HERD's understanding that a deed restriction will be placed on the property limiting future development to commercial/industrial uses.

The approach used to compare analytes to background concentrations was acceptable for Parcel A, although several potential problems were noted in the previous memorandum (February 26, 1998). For future risk assessments on the remaining parcels, HERD should be consulted to determine other more appropriate approaches for background comparisons.

Conclusion

The revised Post-Demolition Risk Assessment is acceptable to HERD and we agree with the risk evaluation presented.

If you have any questions or comments, please contact me at (916) 327-2495.

Reviewed by: Michael J. Wade, Ph.D., DABT MJW
Senior Toxicologist
Human and Ecological Risk

Cal/EPA

Department of
Toxic Substances
Control

245 West Broadway,
Suite 350
Long Beach, CA
90802-4444

Pete Wilson
Governor

Peter M. Rooney
Secretary for
Environmental
Protection

Via U.S. Mail and Facsimile

February 26, 1998

Mr. S. Mario Stavale
Boeing Realty Corporation
4060 Lakewood Blvd., 6th Floor
Long Beach, California 90808-1700

Dear Mr. Stavale:

POST-DEMOLITION RISK ASSESSMENT, BOEING C-6 FACILITY, PARCEL A, LOS ANGELES, CALIFORNIA

The Department of Toxic Substances Control (DTSC) has completed review of the document *Post-Remediation Risk Assessment, Boeing C-6 Facility, Parcel A, Los Angeles, California*, dated February 12, 1998, and received by DTSC on February 17, 1998. Enclosed are the comments of the DTSC Human and Ecological Risk Division (HERD), dated February 26, 1998, on the subject document. DTSC cannot approve the *Post-Remediation Risk Assessment* at this time. The document should be revised to address the comments contained the memorandum from Dr. Deborah Oudiz and resubmitted to DTSC. Also, enclosed in this letter is a memorandum from Dr. Yugal Luthra of HERD, dated February 10, 1998, on surrogate toxicity values and preliminary remediation goals for Parcel A.

DTSC recognizes the need to expedite completion of the risk assessment and would be happy to provide any assistance to further resolve the outstanding issues in a timely manner. If you have any questions, please contact me at (562) 590-4944.

Sincerely,

Karen Baker

Karen Baker, Unit Chief
Southern California
Permitting Branch

Enclosures

cc: Dr. Deborah Oudiz
Human and Ecological Risk Division
Department of Toxic Substances Control
P.O. Box 806
Sacramento, California 95812-0806

Mr. Michael Young
Integrated Environmental Services, Inc.
3990 Westerly Place, Suite 210
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Mr. Jim Ross
Regional Water Quality Control Board -
Los Angeles Region
101 Centre Plaza Drive
Monterey Park, California 91754-7500

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Cal/EPA

Department of Toxic Substances Control

400 P Street, 4th Floor
P.O. Box 806
Sacramento, CA 95812-0806

MEMORANDUM

Pete Wilson
Governor

James M. Strock
Secretary for Environmental Protection

TO: Karen Baker
Supervising Geologist
Hazardous Waste Management Branch
Southern California Region
245 West Broadway, Suite 425
Long Beach, CA 90802

FROM: Deborah Oudiz, Ph.D. Deborah Oudiz
Senior Toxicologist
Human and Ecological Risk Division

DATE: February 26, 1998

SUBJECT: Mc Donnell/Douglas (Boeing): Post Demolition Risk Assessment
PCA 24120 Site Code 400627/50 MPC 44

The Human and Ecological Risk Division (HERD) was requested by you to review the Post Demolition Risk Assessment for the McDonnell Douglas site in Los Angeles near Torrance. This document was received in the HERD office on Wednesday, February 18, 1998. The Los Angeles Regional Water Quality Control Board (LARWQCB) is the lead agency for this site. The current documents only address the residual soil contamination and risks associated from direct and indirect soil exposures. The LARWQCB is addressing groundwater contamination, and DTSC/HERD are not involved in reviewing documents pertaining to this issue. Additionally, the soil was not evaluated for fate and transport to groundwater in these documents. The question of protection of the underlying groundwater, beneficial use of the water, and whether residual soil contamination poses a threat to groundwater will be determined by the LARWQCB.

DTSC and HERD have met on several occasions with the LARWQCB, Boeing staff, and Integrated Environmental Services (IES). At the last meeting on February 9, 1998, agreements were reached concerning the indoor air model and industrial/commercial exposure parameters. DTSC/HERD are aware of the tight timeline for this project and agreed in this meeting to expedite review of the HRA.

The McDonnell Douglas site has been divided into four parcels, all of which are being evaluated and remediated in sequence. The site characterization and risk assessment are for Parcel A, which is located on the corner of Normandie Avenue and 190th Street. The other parcels will be evaluated in the future. The documents reviewed and conclusions in this memorandum only are relevant to Parcel A. The current risk assessment document reflects current conditions at Parcel A. Contaminated soils on the site were excavated prior to preparation of these documents. The excavation and criteria used to determine soil removal were not overseen, supervised or approved by DTSC/HERD, although DTSC/HERD were aware that excavation and demolition were occurring on Parcel A. It is the understanding of DTSC/HERD, IES, and Boeing that the current risk assessment will be used to determine residual risk and the need for further remediation on Parcel A, if necessary.

Documents Reviewed

Post Demolition Risk Assessment, Boeing Realty Corporation, C-6 Facility, Parcel A. Los Angeles, California, February 12, 1998. Prepared by Integrated Environmental Services, Inc. Newport Beach, California.

In addition the following document was used to verify sampling data:

Parcel A - Phase II Soil Characterization, McDonnell Douglas Realty Company, C-6 Facility. Los Angeles, California. Volume I, July 9, 1997. Prepared by Kennedy/Jenks Consultants, Engineers and Scientists, 2151 Michelson Drive, Suite 100, Irvine, California 92612-1331.

General Comments

Parcel A has been extensively and thoroughly characterized and the soil sampling data presented in the Phase II Soil Characterization document appear to be adequate and appropriate for use in the risk assessment. HERD assumes that both DTSC and the LARWQCB have evaluated these data and that the data meet all criteria for QA/QC. DTSC regional staff have not reviewed the soil confirmation reports (MW 1997a, 1997b, 1997c, 1997d, 1997e), and HERD has not received the documents. We recommend that the LARWQCB review these documents if they have not done so already. For the most part, the data presented in the Phase II Soil Characterization do not suggest that there are extremely contaminated areas in Parcel A. The current human health risk assessment (HRA) predicts relatively low cancer risks (below 10E-06) and hazard indices (HI) below 1 for the exposure scenarios evaluated in the main portion of the text (page 6-11). While HERD has a number comments on the risk assessment procedures, we do not anticipate that risk estimates will be elevated to levels which would pose a significant risk, with a few notable hot spot exceptions (see General Comment 3). The recalculated risks may be in the range of 1×10^{-5} cancer risk. The following are major concerns which need to be addressed in any revised document. Specific Comments are included in the next section.

1. The exposure scenarios are based upon a deed restriction for this property. DTSC/HERD do not know what the extent or content of this deed restriction will be, and therefore, we are at a disadvantage in reviewing the HRA. At various points in the HRA it is stated that a deed restriction will be instituted to presumably limit development to industrial uses; that the deed restriction will include prevention of water usage from underlying aquifers; and that agricultural use of the land will be prohibited. It is also implied that since the parcel is designated industrial use, that it will be paved and direct soil contact exposures will be eliminated for certain exposure scenarios. It is not clear if a maintained cap is proposed as a part of the deed restriction, or if this is just a future use assumption. If a maintained cap is not included in the deep restriction, it cannot be assumed that one will exist under all property uses in the future. Clarification on the content and extent of the deed restriction are needed in order to support the assumptions in the HRA.

2. The only sampling data that are presented in the HRA are the log 95%UCL and maximum concentrations for chemicals of potential concern (COPCs). It is stated on pages 2-2 and 2-3 that soil data for the HRA were taken from the Phase II Soil Characterization (July 1997) and from soil confirmation reports (MW 1997a, 1997b, 1997c, 1997d, 1997e). DTSC and HERD have not reviewed the soil confirmation reports which the HRA data were, in part, based. The HRA document must be sufficiently complete to support the risk analyses contained in it. In order to accomplish this, a summary of data set on which the analyses are based on must be included in the document. At minimum this should include detection limits, minimum and maximum detections, arithmetic mean, 95%UCL (if sufficient number of samples), depth and location of samples. Currently, HERD does not know which data were used for the calculation of risks on Parcel A. A complete set of the data used in the HRA should be made available to DTSC. In order to expedite review of the project, HERD requests that the data set used for the HRA be submitted in an electronic format so that it can be evaluated. Furthermore, HERD requests that DTSC regional staff review the HRA data base and verify the acceptability of the data.

3. HERD and IES agreed to use the background data from the neighboring site, International Light Metals (ILM) in order to determine which inorganic compounds are related to ambient (background) conditions and which may be related to contamination on Parcel A. At the time, we agreed to compare the background data with the 95% UCL value of the site data set. This approach worked fairly well for most of the inorganic contaminants, identifying them as comparable to background concentrations; however, the approach did not identify what appears to be arsenic contamination on site. The Phase II Soil Characterization document reports 796 samples which were analyzed for arsenic. All but seven of these analyses were below the detection limit of 1 ppm. The seven detections were 12, 14, 36, 55, 90, 150,

and 350. All arsenic hits were located in the southern leg on Normandie Avenue, and all except the 12 and 14 ppm hits were in the top 1 to 1.5 feet of soil. The other two hits were both at four feet. It is apparent that the large number of nondetect data points obscured an area with arsenic contaminated soil. The highest hit of arsenic is three orders of magnitude above the USEPA Region IX Residential PRG, and considerably above the background data point cited for the ILM data set. The arsenic values above 14 ppm are considered elevated and attributable to contamination on the site. Arsenic should be added to the COPC list and, where clearly elevated above background, evaluated for risks. The arsenic contamination appears to localized to the one section, and it may be appropriate to evaluate arsenic as a COPC only for the AOPC (see General Comment 4 for a discussion of AOPCs).

Several of the other metals had maximum concentrations above the background value (log 95%UCL was below the background), but they did not appear as skewed as the arsenic data, with the exception of beryllium. The maximum concentration for beryllium was reported to be 100 ppm, but this value was not reported in the Phase II Soil Characterization report. When the entire data set is received, this discrepancy may be explained.

The entire background data set should be included in the HRA. HERD recommends that other evaluations be considered in the determination of background concentrations in future documents. These may include graphic representation of the distributions, summary statistics, maximum concentrations comparisons, and the Wilcoxon Rank Sum Test. HERD does not necessarily require this for Parcel A at this time if the question of beryllium can be answered and if arsenic is included as a COPC.

4. HERD and IES agreed to divide Parcel A into smaller areas of localized contamination for the purposes of the HRA. The Areas of Potential Concern (AOPC) were defined by plotting soil data that were above the USEPA Region IX Residential PRGs and visually determining boundaries for these areas. In Figure 5-1, IES defined two AOPCs. One of these areas contained a cluster of semi-volatile compounds, and the other AOPC encompassed the balance of Parcel A. DTSC/HERD disagrees with the division and suggests that AOPC 2 be divided into three AOPCs, in addition to AOPC 1. Proposed AOPC2 would be the southern leg of Parcel A along Normandie Avenue (including WCC-8s); proposed AOPC3 should be the narrow strip from Normandie Avenue along area near WCC-3D to just east of WCC-2s; and proposed AOPC 4 should be the remainder of Parcel A. The proposed AOPC 2 would contain the elevated arsenic samples, which are not included in Figure 5-1.

Specific Comments

1. Table 2-1: Many of the USEPA Region IX Residential PRGs do not agree with the August 1, 1996 PRG list. A more current list has not been officially released by USEPA, and HERD has not reviewed any changes to the PRGs from the 1996 list. Furthermore, industrial PRGs were substituted for a number of the residential PRGs. The PRG for Aroclor 1254 on page 2-12 of Table 2-1 should be for the carcinogenic effects, not the noncancer effects. When this PRG is used, this compound should be included as a COPC. Additionally, when the correct PRG is used for indeno(1,2,3-cd)pyrene, this compound should also be included in the COPC list. Correction of the PRGs may also affect the distribution contaminants for the visual determination of the AOPCs.

2. Page 3-1: While the Potency Equivalency Factors (PEFs) for PAHs quoted in Wade 1994 are correct, it is more appropriate to cite the source of the PEFs, Cancer Potency Factors List (CalEPA/OEHHA 1994). Additionally, these values must be included in the risk assessment and clearly stated how they are being applied, i.e. whether it is an adjustment in the cancer slope factor or the exposure intake.

3. Table 3-1: A number chronic inhalation RfDs were incorrect and should be changed to the following values:

trimethylbenzenes	0.002 mg/kg-day
naphthalene	0.04 mg/kg-day
n-butylbenzene	0.29 mg/kg-day
n-propylbenzene	0.29 mg/kg-day
p-cymene	0.1 mg/kg-day
xylene	0.2 mg/kg-day

These values should also be checked in the spreadsheets in Appendices. Several incorrect values were carried over into the hazard indices calculations. Reference sources for each of the RfDs should be indicated on the table, not as a general footnote at the bottom.

4. Table 3-1: The noncancer effects of carcinogens should also be considered. The following RfDs should be used for both oral and inhalation exposures:

PAHs	0.04 mg/kg-day (surrogate value)
TCE	7.35E-3 mg/kg-day (DTSC calculated value)
PCBs	7.0E-05 mg/kg-days(surrogate value)
bis(2-ethylhexyl)phthalate	2.0E-02 mg/kg-day

5. Table 3-2: Please include the inhalation CSFs for the PAHs. The only CSFs that are correct on this table are the ones for the aroclors and dibenzo(a,h)anthracene. Other values are transposed between the oral and inhalation values or wrong. Please check this table and check tables in the Appendices. It should also be indicated that the PAH CSFs are based on benzo(a)pyrene. If PEF adjustments are made on this or other tables, they should be noted.

6. Table 3-3 and page 3-8: HERD generally doesn't correct the oral cancer slope factors (CSF) for gastrointestinal absorption and calculate a separate dermal CSF. This correction tends to unrealistically increase the risks from dermal exposures unless accurate data are present documenting absorption by both pathways. HERD intended its earlier recommendation in the 11/3/97 memorandum to include both RfDs and CSFs.

7. Figure 4-1: All complete exposure pathways should be included in the risk assessment. Several of the pathways were listed as insignificant and later dropped from the risk assessment. In particular, the inhalation pathway for VOCs from groundwater was eliminated on pages 4-14 and 5-17 without supporting documentation. Technical justification for determining that this pathway
should be eliminated should be incorporated into the document.

8. Figure 4-1 and page 4-14: The exposure parameters for the construction worker and industrial/commercial worker scenarios were addressed in the November 3, 1997 and January 29, 1998 memoranda from Dr. Deborah Oudiz to Karen Baker. While these memoranda addressed the draft Health Based Remedial Goals (which were not approved or finalized), IES discussed using the protocols as a workplan for the current risk assessment. In the 11/3/97 memorandum, the exposure frequency for the construction worker was set at 250 days/year with a one year exposure duration. This scenario was also designed to address an intrusive maintenance worker scenario.

During the February 9, 1998 meeting in Sacramento with IES, it was agreed that the commercial/industrial scenario would include direct soil contact exposure pathways, including ingestion, dermal, and inhalation. Standard exposure assumptions apply, except for the following revised exposure parameters:

Exposure frequency = 125 days/year
Skin surface area = 2020 cm^2

The commercial/industrial scenario in the main body of the document only considered inhalation of VOCs in outdoor and indoor air. The exposure scenario, which was requested by HERD, is in Appendix C. HERD strongly believes that these analyses belong in the body of the document and any risk management decisions should be based on the complete exposure scenarios. While we understand that the proposed development of Parcel A includes paving and landscaping all areas outside of buildings, there are no assurances that future use of the land will present different property developments and exposures. Unless a maintained cap is written into the deed restriction, all reasonable long term industrial uses of the property must be considered. When HERD determines that residual contamination on a property does not present significant health risk, it must include the possibility that the soil may not be capped. Direct contact exposures to commercial/industrial workers must be assessed, including ingestion, dermal, and inhalation of vapors and particulates.

In addition, the offsite worker and resident exposure scenario should include inhalation exposure to contaminated particulates from the site.

9. Tables 4-1, 4-2, and 5-3: Chemical specific parameters from the Soil Screening Guidance: Technical Background Document (USEPA, May 1996) should be preferentially used for any chemical for which there are data. This was requested in the November 3, 1997 memorandum from Dr. Oudiz to Karen Baker. It is not necessary to change the parameters for this assessment, but all future documents should contain the values from the SSL document.

10. Page 5-2: IES has identified the 0 - 50 ft interval for fate and transport modeling for the air emissions, which HERD agrees with. In addition, the 1-12 ft interval was identified for direct exposure pathways. HERD generally only considers the top 10 feet for direct exposure pathways for residential scenarios, and may consider even shallower depths for industrial exposure scenarios depending upon site specific conditions. IES and Boeing are aware of our approach and have elected to evaluate the soils to depth of 12 feet for direct soil contact exposure pathways.

11. Page 5-4: Statistical summaries, statistical tests, and other pertinent information is alluded to in this section. These analyses and data summaries should be presented in the document. (See General Comment 2)

12. Page 5-5: The calculation of the log 95%UCL must be documented and the equations and input parameters must be in the text. The formulas and calculations should follow the Supplemental Guidance to RAGS: Calculating the Concentration Term (USEPA, May 1992).

13. Page 5-19: It is stated that site conditions indicate that transport is governed by diffusive conditions. Please be more specific in the text and substantiate the statement.

14. Table 5-6: The particulate emissions should be modeled and added to this table in order to address inhalation pathways. (See Specific Comment 7)

15. Page 5-26: The values for the parameters in equation 5-15 need to be presented in the text.

16. Page 5-26: Please present the other equations used to calculate indoor air concentrations after equations 5-14 and 5-15.

17. Table 6-2: This table should be corrected with the exposure parameter values outlined in Specific Comment 7 and additional exposure pathways must be added to the commercial/industrial worker and offsite scenarios.

18. Page 6-4 and COPC Intake and Risk Calculation Sheets: Inhalation intake estimates and risks from outdoor (ambient) exposures and indoor exposures should be calculated and presented separately. In order for HERD to determine the relative contributions of each pathway to the overall risk, each pathway must be presented separately. Furthermore, HERD recognizes that IES has essentially double counted the soil emissions into air by assuming that all of the emissions are present in both the ambient air and indoor air. HERD also understands the limitations and conservative estimates that are inherent in the indoor air models. Emissions and risks estimated from these models are used to assess both the necessity of potential remediation strategies as well as to indicate where further investigations are needed. If high risks are predicted for indoor air contamination, HERD will often recommend real time monitoring of structures in order to evaluate the actual emissions in a building. The indoor air emissions are evaluated using scientific judgment and perspective in determining the need for potential remediation on a site.

19. Page 6-8: DTSC/HERD considers 1×10^{-6} cancer risk estimate to be a point of departure and the risk management range to be 1×10^{-4} to 1×10^{-6}. The acceptable risk range for a site is the prerogative of the regulating agency and a determination of what value should be established as the significant risk level by IES is not appropriate. HERD considers an HI greater than 1 to be of potential concern, not an HI of 10 as stated in the document. If the HI is at unity, further investigation and evaluation may be warranted, and remedial alternatives may be considered.

20. Page 6-11: While it is agreed that a number of HQ's are added which have different organ endpoints, the summation of HQ's also addresses other concerns of multiple chemical exposures. Chemical interactions, the affect of one compromised organ system on the functioning of other organ systems, and multiple insults to systems not well understood, such as the immune system, are at least recognized by the additivity of both noncancer HQ and

cancer risks. It is not reasonable nor health protective to assume that chemical insults to the organism are isolated events without systemic ramifications.

21. Table 6-3: Regulatory maximums should be eliminated from this table since they infer risk management decisions by IES and regulatory actions by DTSC and the LARWQCB.

Conclusions

The soil characterization data presented in the Phase II Soil Characterization document does not indicate that there are any severely contaminated areas in Parcel A, with the possible exception of a few hot spots of arsenic. The HRA, however, has not adequately documented the risks present on the site and the above comments should be addressed in a revised document. Comments which are not critical and do not need to be changed in the revised document were noted in the above comments. HERD realizes the need to expedite completion of the risk assessment and any possible additional remediation for Parcel A, and would be happy to provide any assistance to further resolve these issues in a timely manner.

If you have any questions or comments, please contact me at (916)327-2495.

Reviewed by: Stephen DiZio, Ph.D., DABT
Senior Toxicologist
Human and Ecological Risk Division

RESPONSE TO COMMENTS

IN
MEMORANDUM DATED NOVEMBER 3, 1997
FROM CAL/EPA DEPARTMENT OF TOXIC SUBSTANCES CONTROL
REGARDING
HEALTH-BASED REMEDIATION GOALS FOR SURFACE SOILS
MCDONNELL DOUGLAS REALTY COMPANY C-6 FACILITY, PARCEL A
LOS ANGELES, CALIFORNIA (AUGUST 1997)

Specific Comments

Comment 1

The exposure scenarios chosen for determining remedial goals are construction worker and industrial/commercial worker. Since an onsite residential scenario is not included, a deed restriction must be developed for the site that would restrict future development.

Response 1

Deed restrictions are presently under development by Boeing Realty Corporation (BRC) and will be provided to the Department of Toxic Substances Control (DTSC) for review once completed.

Comment 2

Several exposure pathways for the industrial/commercial worker scenario were missing. Direct soil contact pathways must be included, which would include: ingestion of soil, dermal contact, and inhalation of particulates. Restricting development of the site to commercial/industrial exposure scenarios would not eliminate the need to evaluate these pathways.

Response 2

A review of the site-specific data on future site development, land use, and grading plans indicates that all remediated areas will be capped with 1 to 2 feet of clean fill material. In addition, the site will be paved, landscaped above grade, and buildings constructed. These structures will preclude the commercial/industrial worker from coming into contact with the residual materials in the soils. However, this does not preclude a maintenance worker (e.g., electrical, plumbing, or sewer worker) from trenching into the residual materials. The maintenance worker represents a contractor hired to visit the site to address a short-term failure in utilities or services.

A review of the pathways, parameters, and past site operations indicates that the anticipated exposure for this receptor would be of shorter duration than, but otherwise identical to, the construction worker evaluated in the HBRG document. In addition, it is highly unlikely that each commercial/industrial development on the site would use the same contractor and require that contractor to be exposed to residual concentrations during each visit. However, the construction scenario presented in the HBRG document assumes that the construction worker is always exposed to the "hot spot" for 126 days per year. A comparison of this estimated duration to contractor history on the BRC property reveals that the construction worker scenario is highly conservative and should be protective of a temporary maintenance worker.

Comment 3

In addition to the direct exposure pathways, fate and transport of contaminants in the soil must be considered. The ambient and indoor air pathways were evaluated, however transport to groundwater has not been evaluated. While it is understood that the RWQCB is overseeing the groundwater contamination, DTSC/HERD still considers transport of soil contamination to all media. Therefore, mobile contaminants should be modeled for movement into groundwater and the associated risks and hazards should be considered in determining remedial goals. These risks do not have to reflect any current groundwater contamination, since that will be addressed by the RWQCB.

Response 3

Fate and transport modeling has been completed for Building 41 and 36 sources (areas of residual soil contamination below the 12-foot excavation limit). The residual concentrations in these areas are significantly higher than the proposed HBRGs and have been shown using SESOIL to not reach the first underlying aquifer. These simulations were conducted for a hypothetical 99-year scenario. The results of this preliminary modeling effort indicate that residual soil concentrations will not impact the underlying aquifer.

A complete discussion of the modeling and results will be included in the post-remediation risk assessment for DTSC and RWQCB review.

Comment 4

Several exposure parameters were not adequate for either the construction worker or industrial/commercial worker scenarios:

- *The exposure frequency for the construction worker should be 250 days;*
- *Soil ingestion for industrial/commercial worker should be 50 mg/kg;*
- *Exposure duration for industrial commercial worker should be 25 years;*
- *Skin surface area for dermal contact should be 5800 cm^2;*

- *Averaging time for construction worker should be 365 days.*

Response 4

Refer to comment response 2.

Comment 5

Remedial goals have not been developed for lead because a background value will be used for lead. The value selected in 110 ppm, based on the ILM background data set. Data from the McDonnell Douglas site indicate that background for that site may be considerably less than this value. The use of the ILM background data may not be appropriate for the McDonnell Douglas site, since many of the inorganic concentrations on site appear to be much lower than these values and they may represent a different site specific background.

Response 5

The ILM background study represents the best available data on the lateral and vertical distribution of lead in soils in the immediate area. At the meeting on November 4, 1997, DTSC, LA RWQCB, and BRC agreed that these values could be used as background at the C-6 site. However, DTSC requested that several of these values be noted as possibly reflecting anthropogenic impacts, when referenced by BRC. This notation will be added for lead in the HBRG and post-remediation risk assessment documents.

Comment 6

Table 2-2: If any of the chemicals without RfDs are identified as chemicals of concern for the post-remediation risk assessment, surrogate values must be used. These values should be determined in consultation with a HERD toxicologist. Furthermore, for the post-remediation risk assessment, all detected organic chemicals from the preremediation site characterization and all inorganic chemicals above agreed upon background concentrations, must be included as chemicals of concern. This includes any chemical which may be remediated below agreed upon remedial goals.

Response 6

DTSC will be consulted regarding surrogate toxicity values for those COCs in the post-remediation risk assessment without published toxicity values. The identification procedures for COCs will be clearly documented in the post-remediation risk assessment and provided to DTSC for review.

Comment 7

Page 2-11: Dermal exposure risks. The oral RfDs were adjusted for GI absorption efficiency and then used for estimating dermal risks and hazards using dermal absorption

BOE-C6-0133587

adjustments in the intake equations. While there is a justification for adjusting both parts of the risk equation, HERD generally does not adjust the oral RfD for dermal absorption. This adjustment in the past has been found to produce risks from dermal exposures which were unrealistically high.

Response 7

As recommended, oral RfDs will not be adjusted using GI absorption efficiency for dermal exposure quantification. This change will be incorporated into the HBRG and post-remediation risk assessment documents.

Comment 8

Page 2-12: HERD does not have toxicity equivalency factors (TEFs) for PCBs at present. The only TEFs which we recognize are for dioxins and PAHs. Furthermore, all carcinogenic PCBs are evaluated using the California cancer slope factor of 7.77E+00.

Response 8

HBRG values will be generated for all PCBs using the California cancer slope factor of 7.77E+00. This change will be incorporated into the HBRG document.

Comment 9

Table 2-4: Cancer slope factor for PCBs was not identified, and only Aroclor 1016 and 1254 were identified for remedial goals. Please include all PCBs and develop remedial goals based on cancer risks.

Response 9

HBRG values will be generated for all PCBs using the California cancer slope factor of 7.77E+00. This change will be incorporated into the HBRG document.

Comment 10

Tables 2-3 and 2-4: Please indicate the source for each RfD or cancer slope factor within the tables.

Response 10

Individual references will be provided for all toxicity values used in the post-remediation risk assessment. This will correspond with the surrogate approval process outlined in our response to comment 6.

Comment 11

Table 4-2: HERD uses the dermal adsorption values listed in the 1994 PEA Guidance manual. The values listed in the document are very close to these values and do not need to be changed for the remedial goals; however, any future documents, such as the post-remediation risk assessment, should comply with the PEA values.

Response 11

Updated dermal adsorption values will be incorporated into the post-remediation risk assessment.

Comment 12

Table 2-6: The oral slope factor should be used for the dermal cancer slope factor for hexavalent chromium.

Response 12

The oral slope factor will be used for the quantification of dermal exposures to hexavalent chromium.

Comment 13

Table 4-3: Chemical properties used in this table should be taken from the US EPA Soil Screening Guidance User's Guide, April 1996.

Response 13

The chemical properties presented in Table 4-3 will be reviewed against those presented in US EPA's *Soil Screening Guidance User's Guide* (April 1996). The applicability of each value will be determined based on site conditions. The selected values will be presented and cited in the post-remediation risk assessment.

Comment 14

Page 4-11: The use of 0.07 for the air filled porosity of the soil matrix should be justified by empirical data from the site. The soil does not appear to be a heavy clay mixture and this value may not represent soil matrix conditions. The assumed area of contiguous contamination (A) is 484 m^2 taken from the PEA. This is a residential scenario assumption and may not be appropriate for the site specific exposure scenarios. Please provide additional support for the use of this value.

Response 14

Soils in the upper 20 feet of the C-6 site range from silty sands to dense clays. Empirical data collected at the site indicate an average soil moisture content of approximately 20 percent. Several of the clay samples have been shown to exceed these values significantly. The bulk density of materials ranges from 1.6 to 2.15, with an average of 1.87. Porosity values range from 0.32 to 0.47, with an average of 0.42. These values were obtained during the Kennedy/Jenks Consultants Phase II Soil Characterization study, and during the characterization of import backfill materials, as presented in Attachment A, below. The calculated air-filled porosity using the averages of this empirical data set is 0.06. This value is 15 percent lower than the value used in the development of HBRGs.

In response to the second portion of the comment, the estimated area of contiguous contamination is irrelevant to the findings of the indoor air concentrations projected by the Daugherty model. This value is used simply as a conversion factor for transforming the building volume into a mixing height within the building. In the post-remediation risk assessment, the building volume and area values will be changed to reflect the projected building volume and area under the proposed development.

Comment 15

The Daugherty Model (1991) was used to calculate indoor air concentrations. While we have discussed this previously, there is still some concern in HERD that this model may differ dramatically from the Johnson Ettinger Model (1991) which is in current use by HERD in CalTox®. In order to resolve this, we suggest that several of the known volatile chemicals on site by modeled using Johnson Ettinger and the results compared to the Daugherty calculations. With this additional information, a reasonable determination of appropriateness of the model selection can be made.

Response 15

Integrated has conducted a detailed analysis of the Daugherty and Johnson-Ettinger models. When applied correctly, there is no difference between the findings of the Daugherty and Johnson-Ettinger models under diffusive conditions. Equation 23 of the Johnson and Ettinger paper was compared with the Daugherty model and found to provide the same results for the BRC site using empirical and site-specific data.

Attachment B, below, summarizes the comparative analysis conducted by Integrated for the two models.

Comment 16

Page 5-1: The National Contingency Plan identifies the 10^{-6} risk level as the point of departure for risk management decisions, and the risk range from 10^{-4} to 10^{-6}. The 10^{-4} is not a target concentration, nor is generally used in site remediations. Furthermore, the

10^{-5} risk level for Proposition 65 is not relevant for setting remedial goals for sites. The appropriate risk level for remedial goals is a risk management decision. The assertion that the goals selected for this site are considerably more conservative than what is usually chosen is erroneous and misleading. Given the large number of compounds listed in this document, a 10^{-8} risk level is probably not adequate when cumulative effects are considered. For the intended use of these goals, HERD strongly recommends the use of 10^{-7}. The use of 0.2 for the hazard Quotients is acceptable, although the justification based on relative source contribution is inaccurate. Relative source contribution generally refers to either other environmental sources of the compound, or fraction of exposure to a given medium from a particular contaminated source. The use of 0.2 HQ does recognize the potential for additive effects of the individual compounds on the site.

Response 16

The values referred to were presented for comparative reference purposes only. The discussion does not conclude or imply that the C-6 site should adopt any standard exceeding 10^{-6}. The discussion only presents the relative conservatism inherent in the development of HBRGs based on an incremental lifetime cancer risk equal to 10^{-6} and a hazard index equal to 0.2.

The HBRGs prepared for the site will be used as screening tools during the ongoing excavation and demolition activities to remove those areas that potentially pose a concern. The application of these values in no way dictates the end of human health impact assessment or remediation. As noted in the HBRG document, cumulative risk will be addressed under the post-remediation risk assessment. These risk projections will be presented to DTSC for review, thus ensuring that the final remediation meets a 10^{-6} risk and 1.0 hazard index. BRC will conduct any remediation necessary to ensure that the site meets these goals after the application of the HBRGs.

Comment 17

How are the remedial goals going to used at the site? Will all soil samples be below these goals or will some statistical measure of the contaminated soil samples be compared with the goals?

Response 18

HBRGs will be compared to each individual data point collected from the top 12 feet of soil at the site. Samples will not be averaged or weighted during the HBRG screening process. Soils found to exceed any HBRG will be excavated for treatment or disposal. All imported backfill material will be sampled to ensure that no HBRGs are exceeded.

ATTACHMENT A

Site Soils Data

Table A-1
Soil Characterization Data

Sample ID	Depth (feet)	Moisture Content %(cm3-H2O/g-soil)	Bulk Density (g/cm3)	Total Porosity
SA-NW-5-20	20.0	19.90	1.88	0.42
1A-17-17	17.0	22.50	1.96	0.40
1A-17-15	15.0	13.60	1.61	0.48
2-11-15	15.0	14.50	1.80	0.43
3-1-15	15.0	17.20	1.88	0.40
3-2-15	15.0	17.90	1.84	0.43
4-3-15	15.0	13.80	1.77	0.43
5-4-16	16.0	20.70	1.90	0.42
5-20-15	15.0	12.60	1.61	0.48
6-4-15	15.0	24.80	1.79	0.47
6-17-15	15.0	22.50	1.79	0.45
1-26-11	11.0	15.70	1.95	0.39
SA-NE-8-11.5	11.5	17.40	2.15	0.32
C1-GS-1C-1.5	1.5	22.40	2.07	0.37
C1-GS-2A-2	2.0	35.30	1.96	0.45
C1-GS-3C-3.5	3.5	24.80	1.99	0.41
Average	**12.7**	**19.73**	**1.87**	**0.42**

Note: Data set includes Kennedy/Jenks Phase II Soil Characterization and import soil analytical data.

Calculation of Air-Filled Porosity

Air-filled porosity is calculated using the following equation from Cal/EPA's Preliminary Endangerment Assessment Guidance Manual, Appendix B (Cal/EPA 1994):

$$P_a = P_t - \theta_m \times \beta$$

where:

P_a	Air filled porosity (unitless)
P_t	Total porosity (unitless)
θ_m	Soil moisture content (cm^3- water/ g-soil)
β	Soil bulk density (g/cm^3)

Substituting the following BRC site-specific values into the equation yields:

P_a	Average air filled porosity (unitless)
P_t	Average total porosity, 0.42 (unitless)
θ_m	Average soil moisture content, 0.19 (cm^3- water/ g-soil)
β	Average soil bulk density, 1.87 (g/cm^3)

$$P_a = 0.42 - (0.19 \times 1.87) = 0.64$$

Depending on the rounding of the soil moisture value, the projected site-specific value is 10 to 25 percent below the value used in the HBRG document.

ATTACHMENT B

INTRODUCTION

The intrusion into and subsequent accumulation of contaminant vapors in future buildings at the BRC site must be evaluated for potential human health prior to site closure. DTSC has asked Integrated to provide a detailed evaluation of the Daugherty and Johnson-Ettinger models for the estimation of potential indoor air concentrations.

Integrated has conducted a thorough a review of the Johnson-Ettinger and Daugherty models and has found that the results of these models are the same when the Johnson-Ettinger model is applied properly and empirical or site-specific data are incorporated.

The following summarizes the analysis conducted by Integrated and demonstrates the similarities and differences on a compartmental basis between models. However, prior to the comparative analysis, a review of site-specific data was conducted to identify the transport mechanisms present at the site.

TRANSPORT MECHANISMS

In the Johnson and Ettinger paper (1991), the issue is put forth that initially both convection and diffusion must be evaluated in the indoor air calculation. Integrated completed this evaluation in the selection of the model for the HBRG document. The Johnson-Ettinger model has been designed to estimate – on a screening level basis – the intrusion rate of contaminants as a result of both diffusion and convection. The Daugherty model used in the development of HBRGs is designed to quantify only diffusive impacts. The following discussion describes how to determine the dominant transport mechanism based on site-specific data.

Diffusion is defined as the ability of gas to mix spontaneously and spread throughout another gas. Diffusion is the transport mechanism quantified in the HBRG document. Convection is defined as transport induced by pressure differentials. Convection was not quantified in the HBRG and can be shown to be insignificant at the site.

As noted by Johnson and Ettinger, "the current level of understanding is that both diffusion and convection contribute to vapor intrusion and specific site characteristics will determine the significance of each." The fundamental site characteristic that determines the dominant mechanism at any site is soil permeability (k_v). In their detailed sensitivity analysis of the model results as a function of varying permeabilities, Johnson and Ettinger were able to identify a transition point at which the dominant mechanism can be identified. This transition occurs near a k_v of 1×10^{-8} cm^2: "For $k_v < 10^{-8}$ cm^2, the soil gas rate through the cracks becomes so low that diffusion is the dominant transport mechanism and α [vapor intrusion rate] is therefore independent of k_v. For $k_v > 10^{-8}$ cm^2, on the other hand, contaminant vapors are swept into the building primarily by convection" (brackets added).

Applying these findings and reviewing the site-specific data collected in the Kennedy/Jenks Consultants Phase II Site Characterization study, it is clear that the dominant mechanism of vapor migration at the site is diffusion. Soil permeabilities in the upper 50 feet at the site range from 3.0×10^{-9} to 3.0×10^{-12} cm^2. This is nearly an order of magnitude below the transition point identified by Johnson and Ettinger.

Based on these findings and the work conducted by Johnson and Ettinger, it is Integrated's opinion that convection is not a significant mechanism of vapor transport at the site and that the model selected for fate and transport analysis at the BRC site must conservatively quantify diffusive transport. The Daugherty and Johnson-Ettinger models both estimate indoor air concentrations as a function of diffusive transport. To better understand the variance in projected values between these models, a component-specific comparative analysis is necessary.

COMPARATIVE ANALYSIS

The models evaluated in this comparison are the Daugherty model and the reduced, diffusive-state Johnson-Ettinger model as presented in Equation 23 of the Johnson and Ettinger paper.

Note: Equation 21 of the Johnson and Ettinger paper, the complete Johnson-Ettinger model, was reviewed for inclusion in this report and was found to be inappropriate to the BRC site based site-specific conditions, specifically the new, intact, abovegrade slab foundations. Equation 21 cannot be used for abovegrade slabs; it is designed for belowgrade basements and/or foundations.

On the other hand, the inclusion of Johnson and Ettinger's reduced, diffusive-state equation (Equation 23) is consistent with the intrusion model used in the Cal-Tox and ASTM RBCA risk assessment models.

<u>Daugherty Model</u>

$$C_i = C_{sg}\left[\frac{D_e \times A}{R \times V \times X}\right] \times T$$

where

C_i = Indoor air concentration (mg/cm^3)
C_{sg} = Source soil gas concentration (mg/cm^3)

D_e = Effective diffusivity for compound in site-specific matrix (cm^2/s)
A = Area of infiltration (cm^2)
R = Building air exchange rate (volumes/s)
V = Building volume (cm^3)
X = Depth to source (cm)
T = Ratio of crack area to total floor area (unitless)

Johnson-Ettinger Equation 23 Model

$$C_i = \frac{C_{sg}\left[\frac{D_e \times A}{ER \times X}\right]}{1+\left[\frac{D_e \times A}{ER \times X}\right]+\left[\frac{D_e \times A \times L_f}{D_f \times A_f \times X}\right]}$$

where

C_i = Indoor air concentration (mg/cm^3)
C_{sg} = Source soil gas concentration (mg/cm^3)
D_e = Effective diffusivity for compound in site-specific matrix (cm^2/s)
D_f = Effective diffusivity for compound in crack matrix (cm^2/s)
A = Area of foundation (cm^2)
X = Depth to source, (cm)
ER = Volumetric exchange rate for building,(cm^3/s)
A_f = Area of cracks (cm^2)
L_f = Slab thickness (cm)

Each model is comprised of three functional groups: steady-state vapor flux, foundation attenuation, and indoor air volumetric mixing. The following analyzes the primary functional groups of each model and evaluates their applicability for use at the BRC site.

Vapor Flux

Vapor flux is defined as the rate per unit area at which the contaminant of concern reaches the building. Each model evaluated in this report uses the Farmer model to estimate vapor flux due to diffusive transport (Air/Superfund National Technical Guidance Study Series, Volume II, *Estimation of Baseline Air Emissions at Superfund Sites*, USEPA 1990).

The Farmer model is a simple screening tool originally developed for estimating emission rates from covered landfills exhibiting internal gas generation. It explicitly assumes a constant source concentration (that is, one not decreased by transport or attenuation such as biodegradation), and that the distance between the source and surface remain constant.

The model considers the flux of chemicals to be a result of Frickian diffusion of vapor through soil (USEPA 1992). The resultant estimated vapor flux represents the mass of contaminant passing through a unit surface area in a unit time (e.g., g/m^2s).

It is likely that the Farmer model overestimates contaminant flux because no attenuation or depletion of the source is assumed. However, the model provides a simple method for estimating the probable maximum vapor flux rate (USEPA 1992).

The Farmer model equation for estimating vapor flux is:

$$F = C_{sg} \frac{D_e}{X}$$

where

F = Steady state vapor flux rate (mg/cm^2 s)
C_{sg} = Source soil gas concentration (mg/cm^3)
D_e = Effective diffusivity for compound in site-specific matrix (cm^2/s)
X = Depth to source (cm)

The vapor flux component contained in the Johnson-Ettinger and Daugherty models is shown in bold text in the equations below:

Johnson-Ettinger model

$$C_i = \frac{\mathbf{C}_{sg}\left[\frac{\mathbf{D}_e \times A}{ER \times \mathbf{X}}\right]}{1 + \left[\frac{D_e \times A}{ER \times X}\right] + \left[\frac{D_e \times A \times L_f}{D_f \times A_f \times X}\right]}$$

Daugherty model

$$C_i = \mathbf{C}_{sg}\left[\frac{\mathbf{D}_e \times A}{R \times V \times \mathbf{X}}\right] \times T$$

The flux components of the models are identical. Using trichloroethene as an example, the estimated vapor flux (F) predicted by the Johnson-Ettinger and Daugherty models is:

$$F = C_{sg} \frac{D_e}{X}$$

where

F = Steady-state vapor flux rate (mg/cm^2 s)
C_{sg} = Assumed equal to source soil gas concentration, 1.07×10^{-3} mg/cm^3 (Integrated 1997)
D_e = Effective diffusivity for compound in site-specific matrix, 7.23x10-5 cm^2/s (Integrated 1997)

X = Depth to source, 366 cm (Integrated 1997)

$$F = 1.07 \times 10^{-3}\left(\frac{7.23 \times 10^{-5}}{366}\right) = 2.11 \times 10^{-10}$$

As the example proves, the estimated rate at which trichloroethene will reach any future building foundation is consistent between the models.

The steady-state vapor flux estimation method incorporated in these two models is presented as a conservative, screening-level estimation in the USEPA Air/Superfund National Technical Guidance Study Series, *Assessing Potential Indoor Air Impacts for Superfund Sites* (USEPA 1992).

Structure/Foundation Intrusion Attenuation

Future commercial/industrial developments at the BRC site will incorporate above-grade, slab foundations. This type of foundation can significantly reduce vapor intrusion under diffusive transport conditions (Johnson and Ettinger 1991). This reduction or attenuation must be addressed in the model selected for use at BRC.

Both the Johnson-Ettinger and Daugherty models address the effects of foundation attenuation, but the methods employed differ significantly. The attenuation component of each model is identified in bold type in the equations below:

Johnson-Ettinger model

$$C_i = \frac{C_{sg}\left[\frac{D_e \times A}{ER \times X}\right]}{1 + \left[\frac{\mathbf{D_e} \times \mathbf{A}}{\mathbf{ER} \times \mathbf{X}}\right] + \left[\frac{\mathbf{D_e} \times \mathbf{A} \times \mathbf{L_f}}{\mathbf{D_f} \times \mathbf{A_f} \times \mathbf{X}}\right]}$$

Daugherty model

$$C_i = C_{sg}\left[\frac{D_e \times A}{R \times V \times X}\right] \times \mathbf{T}$$

The Johnson-Ettinger model incorporates two dimensionless groups: 1) an attenuation factor for diffusive flux through the soil matrix and 2) an attenuation factor for intrusion through the foundation.

The Daugherty model uses an empirical ratio of cracking to slab surface area (e.g., 0.0005 cm^2 cracks/cm^2 slab).

An obvious difference between the two models is the diffusive flux attenuation for the soil matrix: the Daugherty model does not consider it. However, an analysis of this parameter indicates that it is insignificant in the estimation of indoor air concentrations under diffusive conditions. Therefore, the rest of this section will focus on the estimation of foundation attenuation.

The estimation of attenuation associated with building structures is considered in both subject models. During the development of mathematical descriptions of foundation effects on vapor intrusion several general assumptions must be made. The two most significant assumptions are:

1. Both models assume that contaminants enter buildings through cracks in the substructure and that diffusion through the foundation material will be insignificant.

2. The Johnson-Ettinger model assumes that all vapors originating directly below the building will enter the building, regardless of transport mechanism, unless the floor is a perfect vapor barrier (Johnson and Ettinger 1991). The Daugherty model assumes that only those vapors originating under the cracked surface will enter the building under diffusive conditions.

Assumption 1 reflects the current thinking that vapor intrusion occurs mainly through cracks, seams, and openings in basements, walls, and floors (Johnson and Ettinger 1991; USEPA 1992). Both models incorporate foundation cracking in the derivation of foundation attenuation. Vapor intrusion through these cracks/openings can be passive under diffusive conditions or accelerated under convective transport. The transport conditions at the BRC site have been shown to be diffusive.

Assumption 2, used only in the Johnson-Ettinger model, restricts contaminant vapor from leaking around a building and adds a significant level of conservatism (Johnson and Ettinger 1991). This conservatism is a function of two fundamental assumptions of the Johnson and Ettinger paper.

First, the vapor flux rate calculated in the models (see "Vapor Flux," above) depends on the concentration gradient between the source soil gas concentration and the target soil gas concentration. "Buildup" of soil gas concentrations under the foundation will significantly reduce the vapor flux. Therefore, all projected soil gas concentrations under the foundation must be either instantaneously diffused into the slab or selectively removed from the equation. The Johnson and Ettinger paper establishes a fundamental assumption that all contaminant flux enters the building to prevent soil gas buildup. The Daugherty model assumes only the soil gas concentrations underlying the cracks will enter the building.

Further complicating the attenuation calculations, Johnson and Ettinger have assumed that no soil gas concentrations leak from around the building. This assumption is highly conservative: "Vapor leakage will be significant whenever the resistance to transport into a building is much greater that the resistance to transport to ground surface, such as buildings built on relatively intact slab foundations" (Johnson and Ettinger 1991).

The product of these two assumptions required Johnson and Ettinger to make fundamental changes to their base model (Equation 21) in the derivation of Equation 23 for diffusive transport. Johnson and Ettinger have placed in the attenuation component of the model a factor that controls the potential buildup of soil gas. The components of this factor are identified in bold below:

$$C_i = \frac{C_{sg}\left[\frac{D_e \times A}{ER \times X}\right]}{1 + \left[\frac{D_e \times A}{ER \times X}\right] + \left[\frac{\mathbf{D_e} \times A \times \mathbf{L_f}}{\mathbf{D_f} \times A_f \times \mathbf{X}}\right]}$$

The derivation of this dimensionless group is not explained in the Johnson and Ettinger paper. However, it represents the diffusion rate of contaminants through the soils relative to the diffusion rate through the foundation. The highlighted parameters are used to ensure that the calculated foundation attenuation does not produce soil gas buildup, thereby violating two of the fundamental assumptions of the paper. Thus, the introduced parameters maintain a balance between the rate of diffusion through the soils and foundation, ensuring that all vapor flux beneath building will enter the building before the development of soil gas buildup.

This is extremely conservative and would significantly overestimate the rate of intrusion into the building under diffusive conditions when, as noted by Johnson and Ettinger, a relatively intact foundation slab is present. Such is the case at the BRC site.

It is these assumptions and equation adjustments that account for the differences between the Daugherty and Johnson-Ettinger models. The following provides a parallel foundation attenuation calculation.

The Daugherty model assumes the ratio of crack surface to slab surface as the foundation attenuation. This approach is consistent with the assumption and currently belief that diffusion driven intrusion is limited to cracks and openings This foundation attenuation method is presented as a conservative, screening-level estimation in the USEPA Air/Superfund National Technical Guidance Study Series, *Assessing Potential Indoor Air Impacts for Superfund Sites* (USEPA 1992). Values range from 0.1 to 0.01 percent. The value used in the HBRG document was 0.05 percent.

The Johnson-Ettinger model calculates the following:

$$T = \frac{1}{1 + \left[\frac{D_e \times A}{ER \times X}\right] + \left[\frac{D_e \times A \times L_f}{D_f \times A_f \times X}\right]}$$

where

T = Diffusive attenuation factor (unitless)
D_e = Effective diffusivity for compound in site-specific matrix, 7.23×10^{-5} cm^2/s (Integrated 1997)
D_f = Effective diffusivity for compound in crack matrix, 7.23×10^{-5} cm^2/s (Integrated 1997)
A = Area of foundation, 1.86×10^6 cm^2 (Integrated 1997)
X = Depth to source, 366 cm (Integrated 1997)
ER = Volumetric exchange rate for building, 6.31×10^4 cm^3/s (Integrated 1997)
A_f = Area of cracks, 930 cm^2 (Integrated 1997)
L_f = Slab thickness, 10 cm

$$T = \frac{1}{1 + \left[\frac{7.23 \times 10^{-5} \times 1.86 \times 10^6}{6.31 \times 10^4 \times 366}\right] + \left[\frac{7.23 \times 10^{-5} \times 1.86 \times 10^6 \times 10}{7.23 \times 10^{-5} \times 930 \times 366}\right]} = \frac{1}{55.6} = 0.018$$

The calculated Johnson-Ettinger foundation attenuation is 1.8 percent cracking. This would correspond to a 1 cm wide crack, running the length of the building, every 55 cm. This value is not realistic; it is an artifact of the parameters introduced by Johnson and Ettinger to address potential soil gas buildup, as noted above.

In conclusion, Equation 23 of the Johnson and Ettinger paper projects foundation attenuation to be 18 to 90 times lower than the empirical values presented in the USEPA Air/Superfund National Technical Guidance Study Series, *Assessing Potential Indoor Air Impacts for Superfund Sites* (USEPA 1992), and 35 times lower than the value used in the Daugherty model.

Indoor Air Volumetric Mixing

Once soil gases reach the interior of the building, building-specific parameters determine the magnitude of indoor air concentration buildup. Both models evaluated in this report incorporate variations of the box model developed by Hwang and Falco in 1986 to estimate long-term air concentrations.

The box model assumes that contaminant concentrations can be reduced only as a function of the air exchange rate within the building. Attenuation associated with chemical reaction, degradation, and diffusion out of the building structure are not accounted for in the model. The box model represents a conservative volumetric mixing model for the estimation of indoor air concentrations.

The following identifies the box model component in each of the studied models and compares the estimated volumetric mixing factors (M):

Johnson-Ettinger model

$$C_i = \frac{C_{sg}\left[\frac{D_e \times \mathbf{A}}{\mathbf{ER} \times X}\right]}{1+\left[\frac{D_e \times A}{ER \times X}\right]+\left[\frac{D_e \times A \times L_f}{D_f \times A_f \times X}\right]}$$

Daugherty model

$$C_i = C_{sg}\left[\frac{D_e \times \mathbf{A}}{\mathbf{R} \times \mathbf{V} \times X}\right] \times T$$

A closer analysis reveals that the product R x V in the Daugherty equation is equal to ER in the Johnson-Ettinger model. Making this substitution the volumetric mixing components are found to be identical. Using the reduced equation presented in the Johnson and Ettinger paper, the estimated volumetric mixing factor (M) is calculated as follows:

$$M = \frac{A}{ER}$$

where

M = Volumetric mixing factor (s/cm)
A = Area of infiltration, $1.86\text{x}10^6$ cm^2 (Integrated 1997)
ER = Volumetric exchange rate for building, $6.31\text{x}10^4$ cm^3/s (Integrated 1997)

$$M = \frac{1.86 \times 10^6}{6.31 \times 10^4} = 29.5$$

Regardless of which model is selected, the estimated indoor air volumetric mixing factor will be identical.

The mixing factor estimation method incorporated in these two models is presented as a conservative, screening-level estimation in the USEPA Air/Superfund National Technical Guidance Study Series, *Assessing Potential Indoor Air Impacts for Superfund Sites* (USEPA 1992).

Projected Indoor Air Concentration

The following equation presents the relationship of the abovementioned model components for the calculation of indoor air concentrations:

$$C_i = \frac{F \times M}{T}$$

where

C_i = Indoor air concentration (mg/cm^3)
F = Estimated steady state vapor flux rate, 2.11x10^{-10} mg/cm^2 s
M = Estimated volumetric mixing factor, 29.5 s/cm
T = Diffusive attenuation factor 2000 (Daugherty model), 55.6 (Johnson-Ettinger model)

Daugherty Model

$$C_i = \frac{2.11 \times 10^{-10} \times 29.5}{2000} = 3.11 \times 10^{-12}\, mg/cm^3 \times 1 \times 10^6\, cm^3/m^3 = 3.11 \times 10^{-6}\, mg/m^3$$

Johnson-Ettinger Model

$$C_i = \frac{2.11 \times 10^{-10} \times 29.5}{55.6} = 1.12 \times 10^{-10}\, mg/cm^3 \times 1 \times 10^6\, cm^3/m^3 = 1.12 \times 10^{-4}\, mg/m^3$$

The differences in projected concentrations is a direct result of the attenuation factor and associated assumptions underlying the Johnson and Ettinger paper.

CONCLUSION

The estimated indoor air concentration is significantly different for the Johnson-Ettinger and Daugherty models. Integrated's review has clearly demonstrated that the differences in these models can be found in the slab attenuations. The attenuation assumptions used by Johnson and Ettinger in the development of their model are highly conservative and, in fact, unrealistic under diffusive conditions. Johnson and Ettinger recognize this in their paper and state that the application of their model is limited by the availability of site specific slab attenuation values.

In addition, the authors state, " A realistic range for η can be proposed by considering physical realizations corresponding to specific values of η. For example, η=0.01 corresponds to a 1-cm wide crack running the length of basement floor/walls every 100 cm." Applying this evaluation to the attenuation factor calculated in Johnson and Ettinger's Equation 23, T=0.018, corresponds to a 1 cm wide crack, running the length of the slab, every 55.6 cm. This value is neither realistic nor reasonable and solely an artifact of the assumptions in Johnson and Ettinger's paper.

To evaluate the Reasonable Maximum Exposure (RME), the calculated attenuation must be adjusted to more closely reflect site conditions; specifically, the empirical values for slab cracking must be used. Thus, the final estimated attenuation and subsequent indoor air concentration would be identical to the values projected by the Daugherty model. Johnson and Ettinger's trial and error approach to adjusting their model to more closely match empirical or site-specific data serves as the basis for the model's classification – *Heuristic*.

It is therefore Integrated's opinion that the proper application of the Johnson-Ettinger model will neither add to the protection of human health nor reduce the uncertainty associated with soil remediation at the BRC site.

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION
101 CENTRE PLAZA DRIVE
MONTEREY PARK, CA 91754-2156
(213) 266-7500
FAX (213) 266-7600

October 22, 1997

Mr. Michael Young
Integrated Environmental Services, Inc.
3990 Westerly Place, Suite 210
Newport Beach, CA 92660

RESPONSE TO COMMENTS - PARCEL A, PHASE II SOIL CHARACTERIZATION - McDONNELL DOUGLAS REALTY COMPANY C-6 FACILITY - LOS ANGELES, CALIFORNIA (FILE NO. 100.315)

We have received and reviewed MDRC's response to our comments on the Parcel A, Phase II Soil Characterization for the McDonnell Douglas Realty Company C-6 Facility in Los Angeles, faxed to us on October 03, 1997. Our comments on the Parcel A, Phase II Soil Characterization Document have been appropriately addressed. We have no further comments on the above referenced document.

If you have any questions or comments regarding the above, please contact me at ~~(213)~~ 266-7550.

J.E. ROSS, P.E., Unit Chief
Site Cleanup Unit

cc: Ms. Karen Baker, DTSC, Long Beach
Ms. Debbie Oudiz, Office of Scientific Affairs
Mr. Fred Strauss, Montgomery Watson, Inc.
Mr. Jeff Dhont, Federal EPA

Cal/EPA

Los Angeles Regional Water Quality Control Board

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Pete Wilson
Governor

March 11, 1998

Mr. Michael Young
Integrated Environmental Services, Inc.
3990 Westerly Place, Suite 210
Newport Beach, Ca 92660

RESPONSE TO DRAFT RWQCB COMMENTS ON POST-DEMOLITION RISK ASSESSMENT, BOEING REALTY CORPORATION C-6 FACILITY, PARCEL A (FILE NO. 95-36)

We have reviewed your Response to Draft RWQCB comments on the Post-Demolition Risk Assessment for the Boeing Realty Corporation C-6 Facility (MDRC), Parcel A. Board staff also discussed the comments with BRC's consultant during a conference call held on March 2, 1998. Our comments, based on the above, are as follows:

1. To evaluate the chemical concentration data, as discussed, we require statistical soil data for the following constituents of potential concern (COPCs) in Table 2-1 (page 2-10): 1,1-dichloroethylene, aroclor1248, aroclor1260, benzo(b)flouranthene, dibenco(a,h)anthrancene, naphthalene, tetrachloroethylene, trichloroethylene, total xylenes, and arsenic. Please provide us with the following data for the COPCs listed:

   a) A histogram plot of field soil data to show the distribution.

   b) The D'Agostino's test results to show either the normal or the log-normal distribution.

2. Please use site-specific soil physical data [soil bulk density = 1.87 g/cm^3, water filled porosity = 0.37 (-), and air filled porosity 0.06 (-)], to recalculate equations (5-1), (5-5), (5-11) and (5-12) for COPC tetrachloroethylene [Koc = 660 mL/g and H=0.957(-)], and tabulate the results in comparison with the current results in the report.

If you have any questions or comments regarding the above, please contact me at (213)266-7550, or Dr. Yue Rong at (213)266-7604.

J.E. ROSS, P.E.
Chief, Site Cleanup Unit

Attachments:

cc: Ms. Karen Baker, DTSC - Long Beach
Mr. Jeff Dhont, Federal EPA
Mr. Mario Stevale, Boeing

INTEGRATED
Environmental Services, Inc.

March 20, 1998

Via Facsimile and Federal Express

James E. Ross, P.E.
Unit Chief, Site Cleanup Unit
Regional Water Quality Control Board
Los Angeles Region
101 Center Plaza Drive
Monterey Park, CA 91754-2156

Subject: Response to RWQCB Memo re. *Post-Demolition Risk Assessment*, March 13, 1998

Project: Boeing C-6 Facility, Parcel A, Los Angeles (RWQCB File No. 100.315)

Dear Mr. Ross:

Integrated has reviewed the comments prepared by the Water Board and has prepared the following materials to further address the remaining two comments.

Comment 1: *To evaluate the chemical concentration data, as discussed, we require statistical soil data for the following constituents of potential concern (COPCs) in Table 2-1 (page 2-10): 1,1-dichloroethylene, aroclor 1248, aroclor 1260, benzo(b)fluoranthene, dibenco(a,h)anthrancene, naphthalene, tetrachloroethylene, trichloroethylene, total xylenes, and arsenic. Please provide us with the following data for the COPCs listed:*

a) *a histogram plot of field soil data to show distribution.*
b) *the D'Agostino's test results to show either the normal or log-normal distribution.*

Response: The data set used in the derivation of exposure point concentrations includes over 200,000 records as presented in Supplemental Books 1-5 of the March 6, 1998, version of the Post-Demolition Risk Assessment (PDRA). Integrated has performed numerous statistical evaluations of the data set prior to the development of the PDRA. The following addresses the RWQCB requested statistical analyses.

a) a histogram plot of field soil data to show distribution

Histograms have been prepared for each of the COPCs as requested by RWQCB in Figures 1-14. A third party statistical analysis software package, *Statistica*™, by StatSoft was used to analyze the COPC hits. Histograms could not be developed for Aroclor-1248, Aroclor-1260, and dibenzo(a,h)anthracene due to their extremely limited detection frequency. These organics were each detected a total of five times in Parcel A. However, these organics have been assumed to be distributed in an identical manner to the other organic constituents evaluated in the PDRA.

Arsenic was the only COPC anticipated to exist throughout the site and thus demonstrate a normal distribution. All other COPCs (organics) were assumed log normally distributed. The enclosed figures demonstrate that the assumptions used in the PDRA concerning the distribution of organic and inorganic constituents at the site where acceptable.

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Figure 1
Fit-Test Distribution Histogram: Assumed Normal

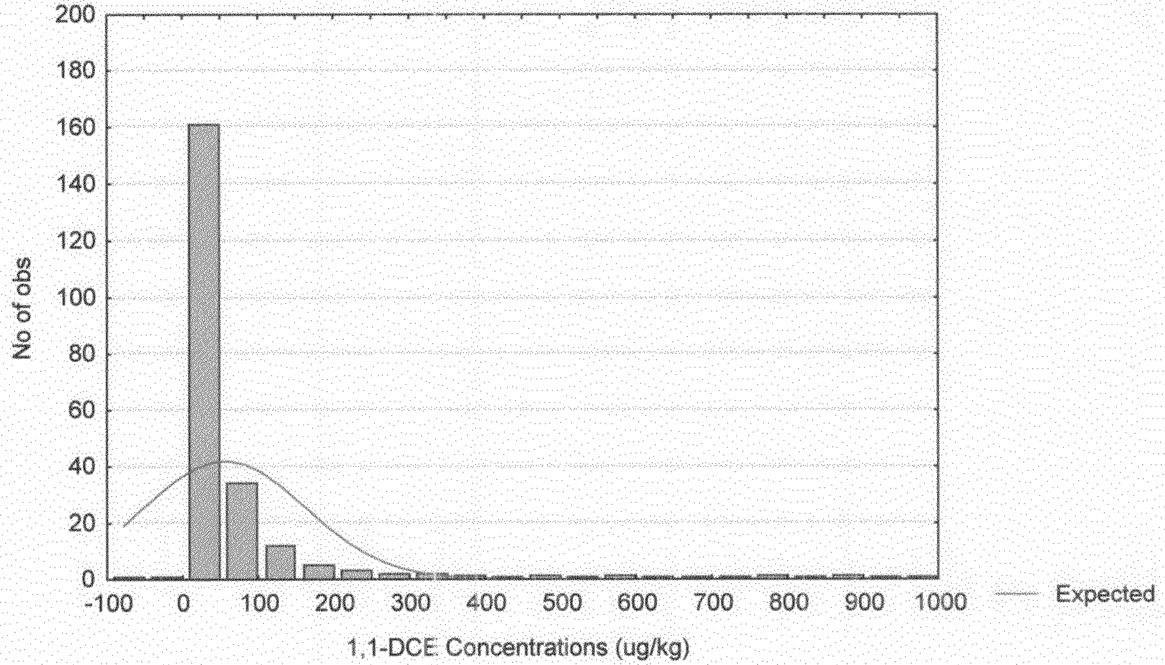


Figure 2
Fit-Test Distribution Histogram: Assumed Lognormal

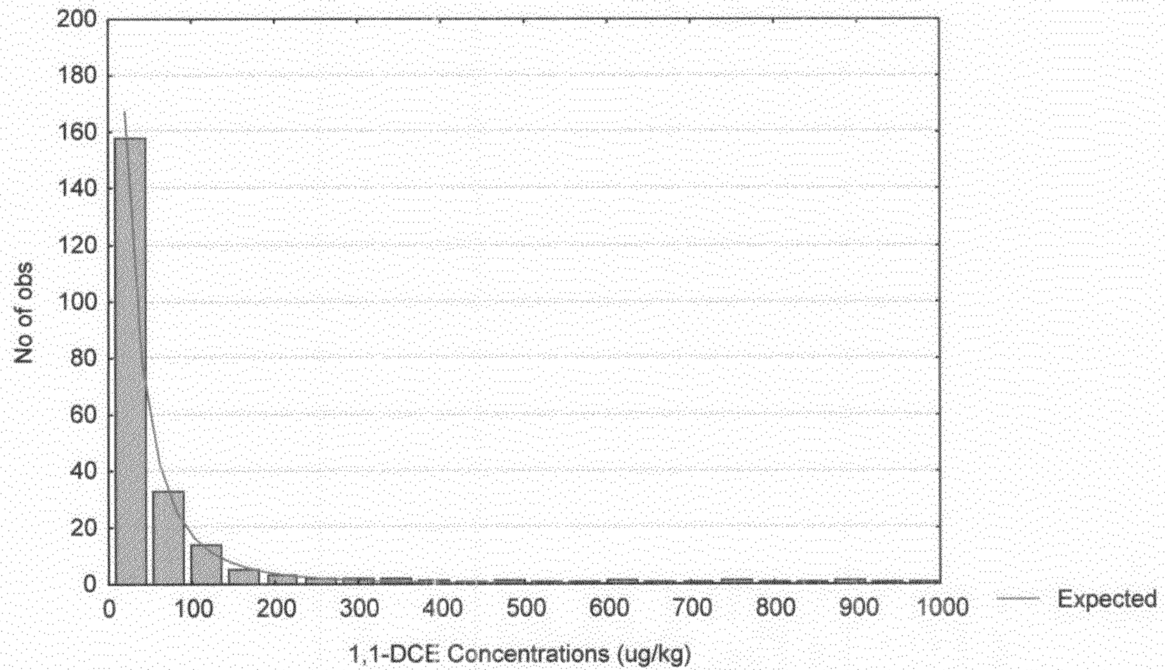


Figure 3

Fit-Test Distribution Histogram: Assumed Normal

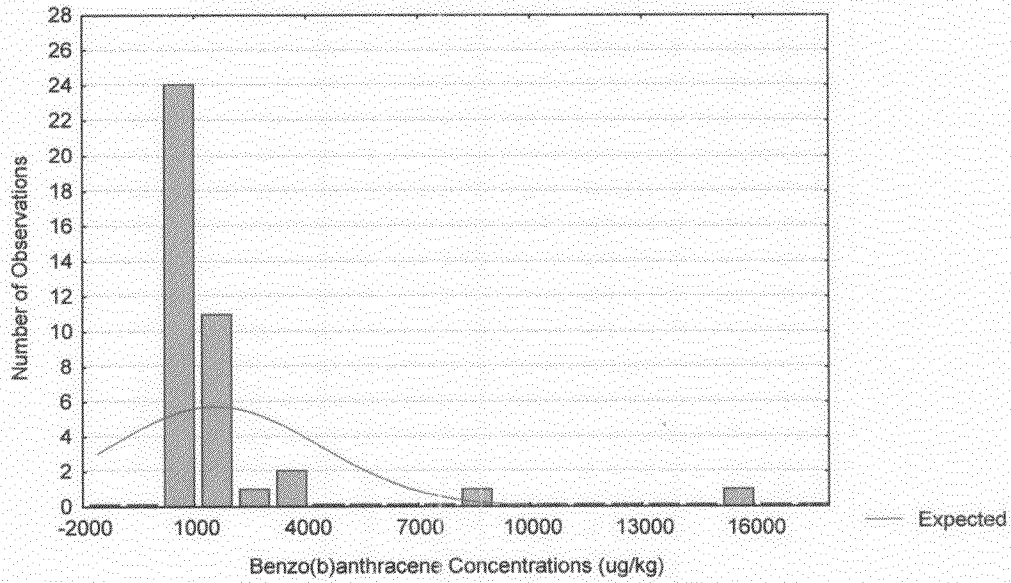
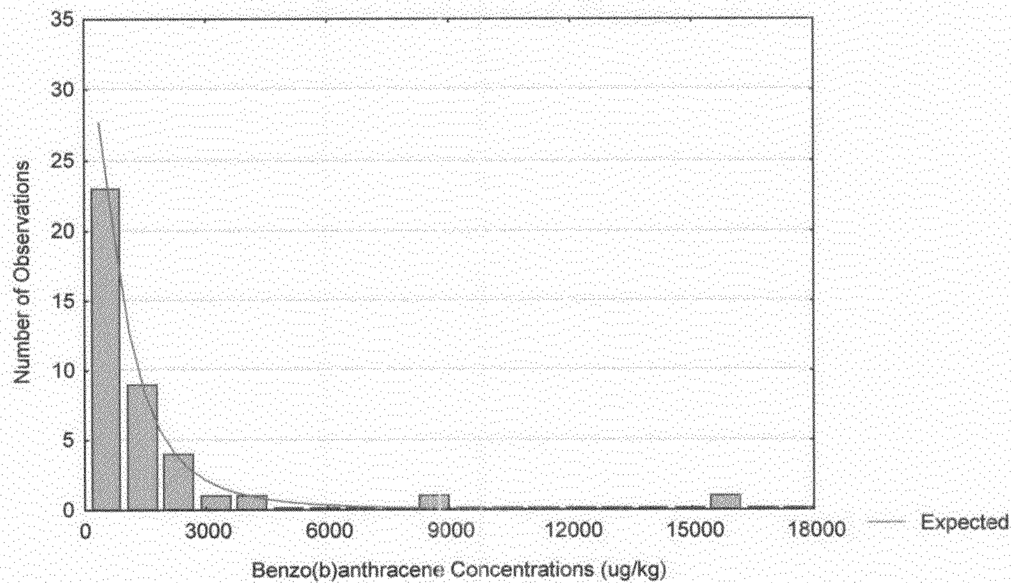


Figure 4

Fit-Test Distribution Histogram: Assumed Lognormal



James Ross
March 20, 1998

Figure 5
Fit-Test Distribution Histogram: Assumed Normal

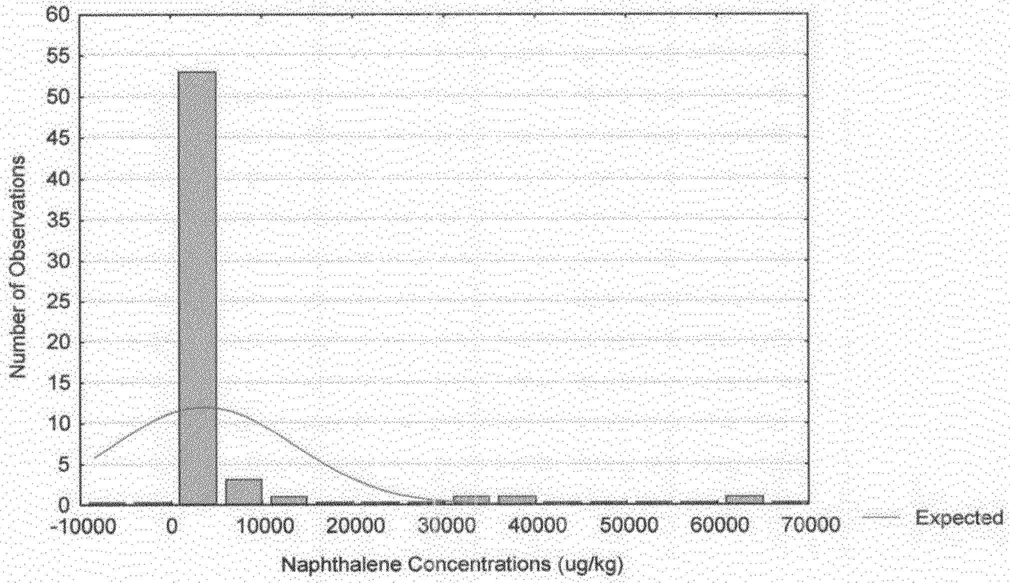
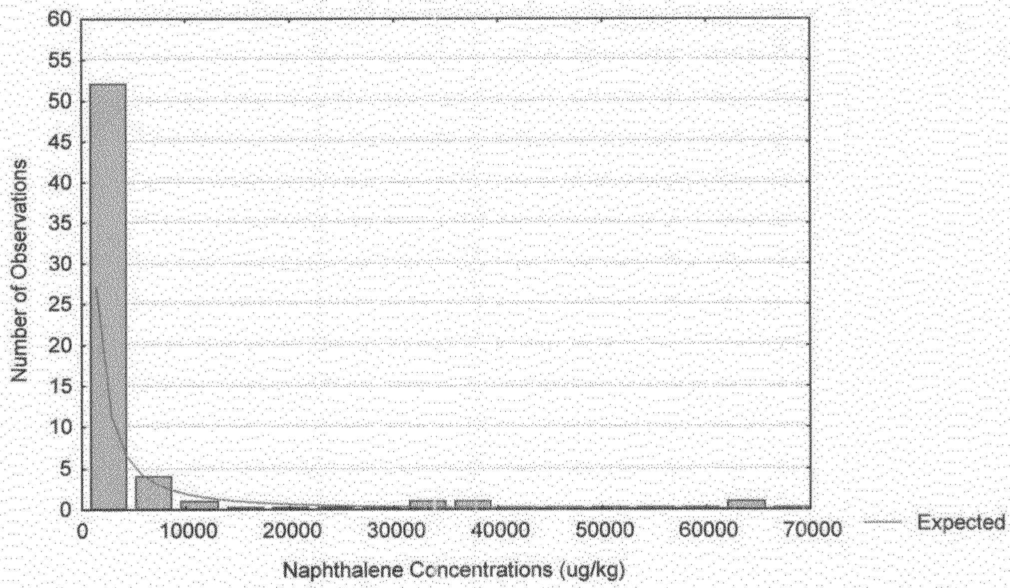


Figure 6
Fit-Test Distribution Histogram: Assumed Lognormal



James Ross
March 20, 1998

Figure 7

Fit-Test Distribution Histogram: Assumed Normal

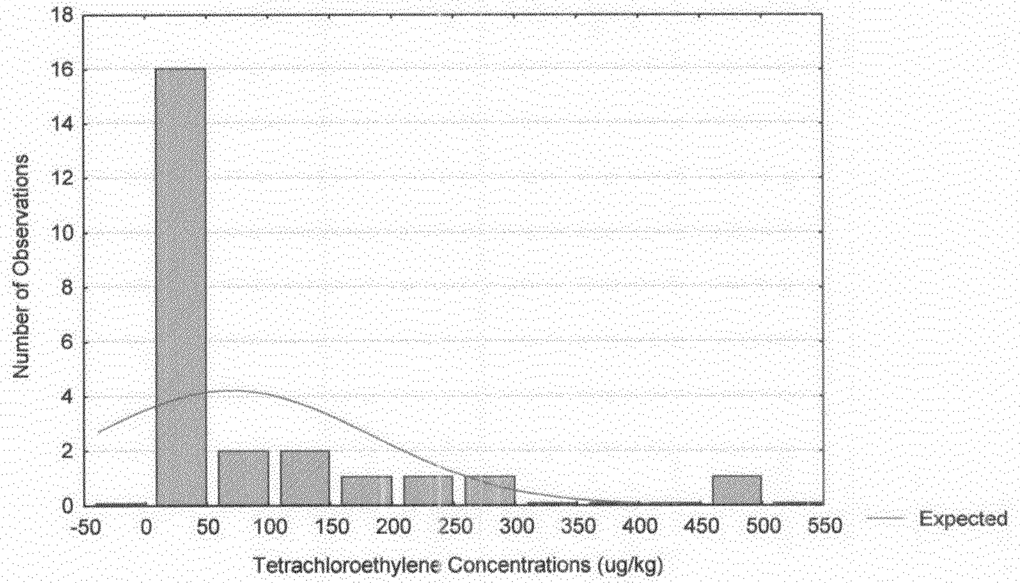


Figure 8

Fit-Test Distribution Histogram: Assumed Lognormal

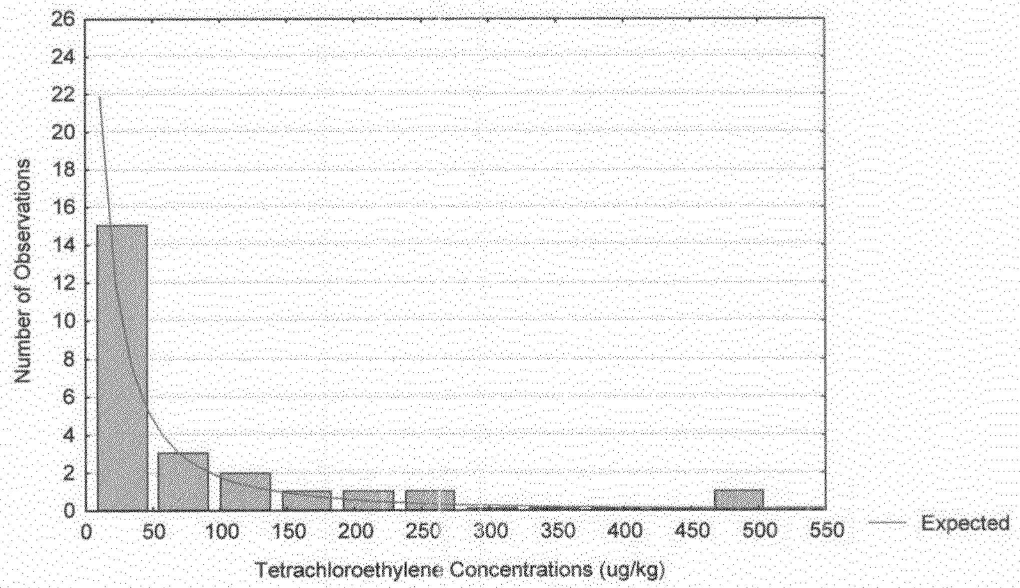


Figure 9
Fit-Test Distribution Histogram: Assumed Normal

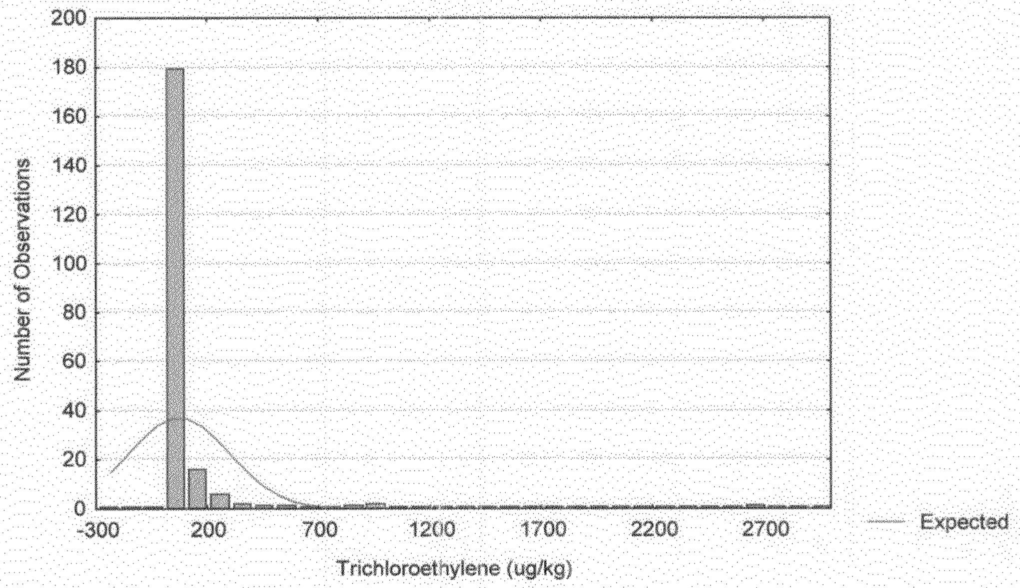


Figure 10
Fit-Test Distribution Histogram: Assumed Lognormal

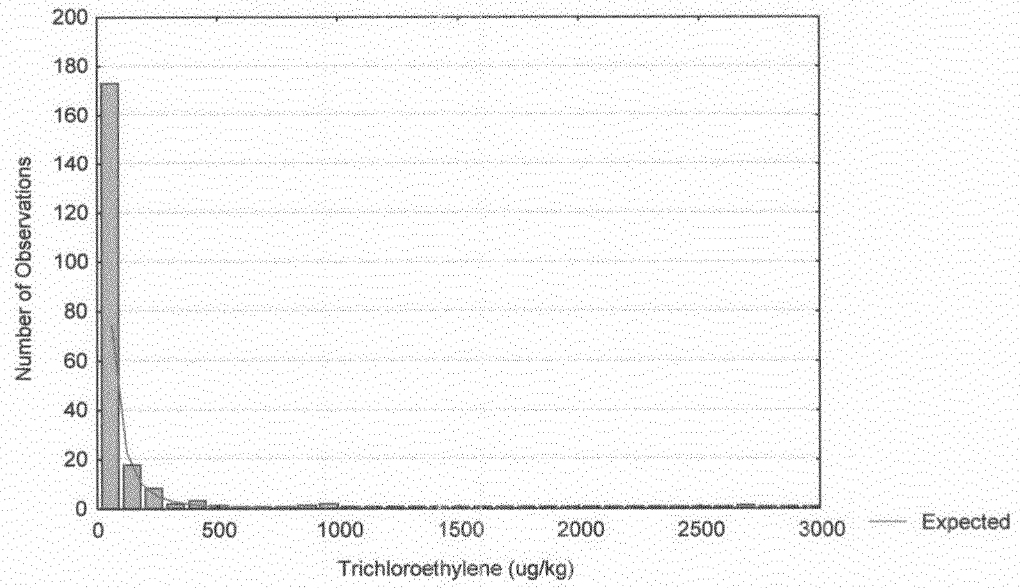


Figure 11

Fit-Test Distribution Histogram: Assumed Normal

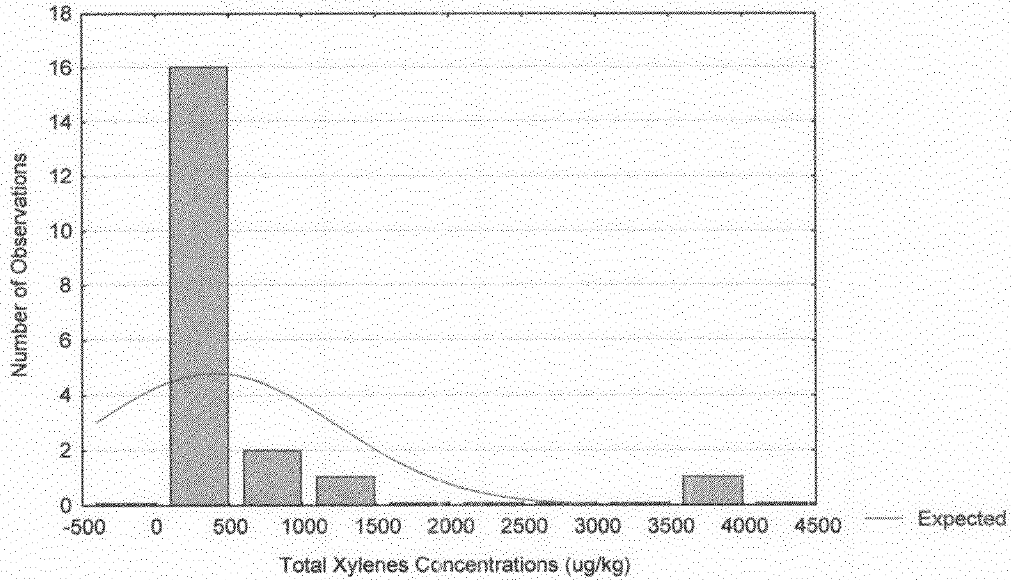


Figure 12

Fit-Test Distribution Histogram: Assumed Lognormal

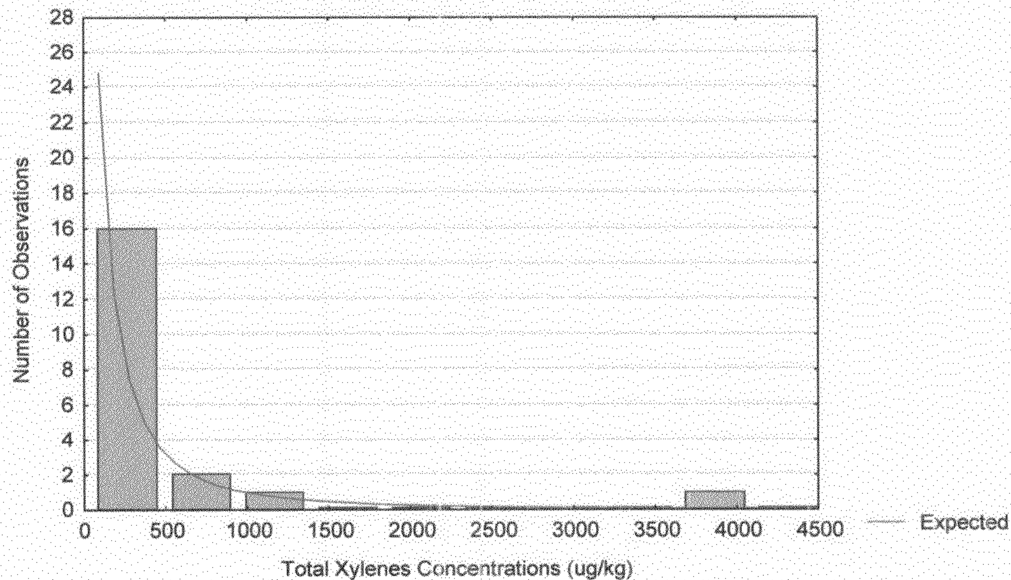


Figure 13

Fit-Test Distribution Histogram: Assumed Normal

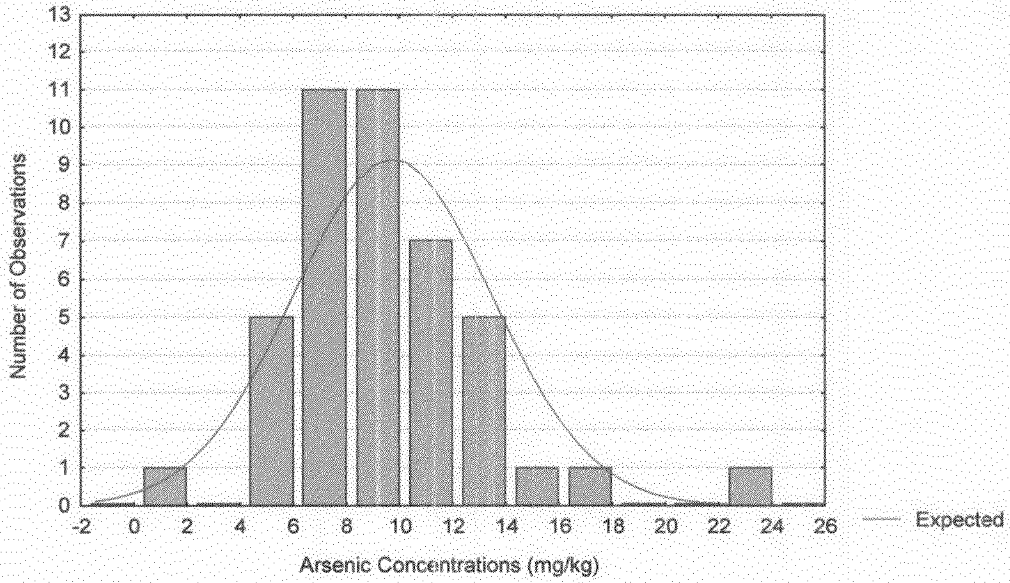
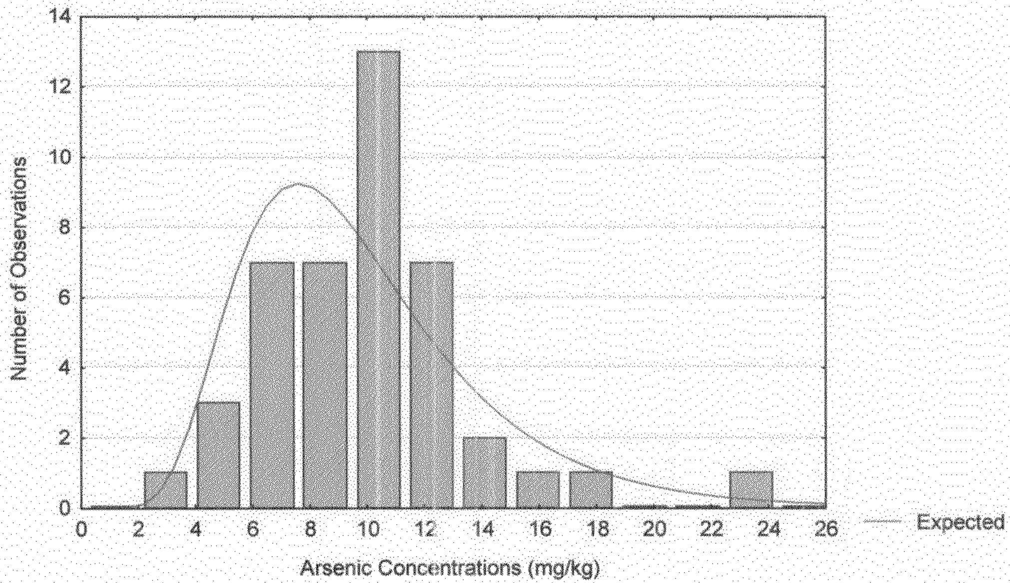


Figure 14

Fit-Test Distribution Histogram: Assumed Lognormal



b) *the D'Agostino's test results to show either the normal or log-normal distribution.*

The D'Agostino's test results were inconclusive and were supplemented with distribution histograms for the determination of data distributions. As noted in DTSC HERD's final policy titled *Selecting Inorganic Constituents as Chemicals of Potential Concern at Risk Assessments at Hazardous Waste Sites and Permitted Facilities* (Cal/EPA 1997), "distributions will generally fail tests for both normality and lognormality if they contain either multiple populations or a high proportion of non-detects." As presented in Table 2-1 of the PDRA, no organic constituents were detected in more than 16 percent of the samples. Thus the majority (>84 percent) of the samples analyzed for organic constituents were non-detects. This localized distribution of organics, with large areas of non-detects is indicative of a lognormal distribution and limited releases to the environmental media. This is consistent with the distribution used in the quantification of risk in the PDRA.

Comment 2: *Please use site-specific soil physical data (soil bulk density = 1.87 g/cm^3, water filled porosity = 0.37(-), and air filled porosity 0.06 (-)) to recalculate equations (5-1), (5-5), (5-11) and (5-12) for COPC tetrachloroethylene (Koc = 660 mL/g and H=0.957(-)), and tabulate the results in comparison with the current results in the report.*

Response: As presented in the subject document and communications between Integrated and RWQCB staff, DTSC-HERD default soil parameters were used to conservatively estimate the rate of emissions from the site soils. Based on the use of these more conservative parameters, this approach ensures that the emissions estimated for the site are not underestimated. The following table has been assembled for the requested comparison with the resultant conservative value highlighted in green:

Equation of Interest	Site-Specific Soil Parameters	PDRA Soil Parameters
(5-1) - Volatilization Factor (m^3/kg)	1.06E+04	3.02E+02
(5-5) - Soil-to-Air Partitioning Coefficient (g/cm^3)	3.60E-01	6.57E-01
(5-11) - Soil Gas Concentration (mg/L)	4.14E-06	7.51E-06
(5-12) - Vapor Flux (mg/cm^2-sec)	2.32E-12	7.32E-10

As shown in the comparison table, the values used in the PDRA are significantly more conservative then the site-specific data for the estimation of emissions. As mentioned in communications with Water Board staff, the most sensitive equations to the parameters identified by the RWQCB are 5-4 and 5-13, the calculation of the chemical-specific effective diffusivity (Dei). The Dei estimated in the PDRA represents a two orders of magnitude higher estimated diffusion rate through the soils.

I appreciate the opportunity to work closely with you and your staff on this important project. Should you or your staff have any further questions concerning the Post-Demolition Risk Assessment, please feel free to call me directly at (714) 852-9050, extension 20.

Sincerely,

Chris Stoker
Program Manager

CC: S. Mario Stavale, Boeing

Cal/EPA

Department of Toxic Substances Control

400 P Street,
4th Floor
P.O. Box 806
Sacramento, CA
95812-0806

MEMORANDUM

Pete Wilson
Governor

Peter M. Rooney
Secretary for Environmental Protection

TO: Karen baker
Geology Section
245 West Broadway, Suite # 425
Long Beach, CA. 90802

FROM: Yugal K. Luthra, PhD MRSC MIBiol
Staff Toxicologist
Science, Pollution Prevention, and Technology Development
Human and Ecological Risk Division

DATE: February 10, 1998

SUBJECT: Surrogate Toxicity Values and Preliminary Remediation Goals (PRGs) for Boeing Parcel A Post-Demolition Risk Assessment..
PCA Code: 24120, Site Code:400627/50, MPC:44

BACKGROUND

HERD (Deborah Oudiz, Senior Toxicologist) received a technical request from C. Stoker, Integrated Environmental Services, to provide surrogate toxicity values for a number of chemicals and also to develop PRGs for all the listed chemicals of potential concern (COPCs), as listed in the technical request, dated January 29, 1998.

LIST OF CHEMICALS

Phenanthrene; 1,2,4- and 1,3,5-Trimethylbenzenes; p-Cymene; 1,2-Dichloroethene; sec- and ter-butyl benzenes; n-butyl- and n-propyl benzenes; p-chloro-m-cresol; 2-methylnaphthalene; methylethylbenzene; benzo(ghi)pyrelene; and indeno(1,2,3-cd)pyrene.

Chemicals in bold were reported to be above 5% detection frequency, and the remaining were designated as surrogates.

TOXICITY VALUES

Chemical	RfD/RfC (mg/Kg)	Slope Factor Oral/Inhal. (mg/Kg-day) -1	PRGs mg/Kg
p-Cymene	**0.1/0.1**	**-**	**785**
(Based on toluene RfC toxicity value).		**-**	
1,2,4-Trimethylebenzene	**0.5/0.002**	**-**	**1197**
1,3,5-Trimethylbenzene	**0.5/0.002**	**-**	**1425**
Phenanthrene	**0.3/0.3**	**-**	**140**
n-Butylbenzene*	**0.1/0.29**	**-**	**164**
n-propylbenzene*		**-**	
sec-Butylbenzene*		**-**	
ter-butylbenzene*		**-**	
(* For these chemicals toxicity value is based on ethylbenzene)			
1-methylethylbenzene	**0.04/0.0026**	**-**	**203**
p-chloro-m-cresol	**0.05/0.05 (Based on m-cresol toxicity values).**		
2-methylnaphthalene	**0.04/0.04 (Based on naphthalene toxicity values).**		
benzo(ghi)perylene	**0.004/0.004**	**-**	**4.2**
indeno(1,2,3-cd)pyrene	**-----**	**1.2/0.39**	**8.5**
1,1-dichloroethene	**0.009/0.009**	**Not Appl.**	**580**

Note: Preliminary Remediation Goals (PRGs) do not account for groundwater pathway of exposure. Toxicity values were obtained from the IRIS database (USEPA - 1997) or HEAST (USEPA- 1997).

CONCLUSION

The PRGs listed above are not necessarily protective of all known human exposure pathways, reasonable land uses, or ecological receptors. Therefore, it is important to ensure that the site conditions and exposure pathways are appropriate for the purpose of assessing risk and/or hazard associated with the concentration of contaminants present at the facility.

As the majority of the listed chemicals are volatile, soil saturation concentrations were calculated. Hazard index was then determined at saturation concentration of the volatile chemicals. If the hazard index resulted in 1 or a smaller value, the PRG was set at the saturation concentration.

From the PRG values listed above, benzo(ghi)pyrelene (noncarcinogenic PAH) and indeno(1,2,3-cd)pyrene (carcinogenic PAH) are the two contaminants that are driving the risk at Parcel A location.

If you may have any questions, please, contact me at (916)327-2512 or 8/467-2512.

Reviewed by: Deborah Oudiz, Phd
Senior Toxicologist (HERD)

mcdglprg.dochrz.

INTEGRATED
Environmental Services, Inc.

February 6, 1998

Karen Baker
California Environmental Protection Agency
Department of Toxic Substances Control
245 West Broadway, Room 350
Long Beach, CA 90802-4444

Subject: **DTSC Memorandum dated January 28, 1998, from Dr. Michael Schum, HERD,** to Karen Baker, Southern California Hazardous Waste Management Branch, on "Review of Air Models to Support Development of Risk-Based Cleanup"

Project: **Boeing Realty Corporation C-6 Facility, Parcel A**
DTSC Site: 400627-50

Dear Ms. Baker:

Thank you for giving us the opportunity to respond to Dr. Schum's memo addressing Integrated's air modeling approach for the Boeing C-6 site. We appreciate the guidance DTSC has provided.

Background

On December 3, 1997, Integrated provided DTSC/HERD with material comparing the Johnson-Ettinger and Daugherty indoor air models. On February 2, 1998, Integrated received Dr. Schum's memo outlining HERD's position on the air models. The following has been prepared in response to Dr. Schum's memo.

Comments

Integrated agrees with Dr. Schum's conclusion that both models are "very conservative." Furthermore, Dr. Schum emphasized the importance of using site-specific data when available. These positions are synonymous with Integrated's positions as put forth in numerous communications.

Several key statements and issues raised by Dr. Schum, however, do not account for site-specific conditions or data collected over the last 10 years of investigation. We understand that such information may not have been available at his office. For example, technical issues 1 and 2 in Dr. Schum's memo do not consider the fact that site data are available for VOCs, permeabilities, backfill materials, etc. As detailed in the sensitivity analysis presented in Johnson and Ettinger's paper (1991), these variables control the mechanism of transport and the magnitude of the resultant indoor air concentrations.

Regarding Dr. Schum's suggested use of 1 percent as a default area cracking fraction (when site-specific data are not available), we believe this would represent a highly unlikely scenario. Such a high value would significantly overestimate—by orders of magnitude—the indoor air concentrations. This is because Johnson and Ettinger recognize that their model assumptions are highly conservative when dealing with "relatively intact" slab foundations. Note that the Boeing slab will be new.

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Integrated believes that when site-specific conditions are accounted for in the modeling input and realistic assumptions used when site-specific data are not available, both models will produce the same estimated indoor air concentrations. This was highlighted in the comparison of models provided in our December 3 memo.

Therefore, since no indoor air modeling precedent has been set at this site, and to facilitate HERD's expedited review, Integrated agrees to use the Johnson-Ettinger model in the forthcoming Post-Demolition Risk Assessment for Parcel A. In the report, site-specific data and conditions will be used before defaulting to general screening values such as those provided in Dr. Schum's memo.

Finally, we would appreciate your cooperation in resolving these issues most expeditiously. Our client, Boeing Realty Corporation, is fast approaching a critical juncture in its property transfer negotiations. As conveyed to you at our June 1997 meeting in Long Beach, Boeing will incur substantial monetary penalties if the Parcel A soils are not closed and approved for development by March 1998. The lead agency, RWQCB-LA, has expressed a willingness to meet the client's deadline if the supporting agencies have completed their work soon enough to allow Water Board signoff.

Sincerely,

Michael Young

Michael Y. Young, Ph.D.
President

cc: Deborah Oudiz, DTSC-Sac.
James Ross, RWQCB-LA
John Hinton, DTSC-LB
Lou Smallwood, Cal/EPA
Lillian Conroe, Cal/BRC
J.T. Liu, Cal/BRC
Michael Schum, DTSC/HERD
S.Mario Stavale, Boeing

February 4, 1998

Cal/EPA

Department of Toxic Substances Control

1011 N. Grandview Ave.
Glendale, CA 91201

VIA FACSIMILE AND U.S. MAIL

Mr. S. Mario Stavale
Boeing Realty Corporation
4060 Lakewood Blvd., 6th Floor
Long Beach, California 90808-1700

Dear Mr. Stavale:

RESPONSE TO DEPARTMENT OF TOXIC SUBSTANCES CONTROL COMMENTS ON HBRG DOCUMENT AND PARCEL A - PHASE II SOIL CHARACTERIZATION, BOEING REALTY CORPORATION C-6 FACILITY (FORMERLY MCDONNELL DOUGLAS)

The Department of Toxic Substances Control (DTSC) has reviewed the *Response to Department of Toxic Substances Control Comments on HBRG Document,* dated December 1, 1997, for Boeing Realty Corporation C-6 Facility (formerly McDonnell Douglas). Enclosed are memoranda, from Deborah Oudiz, Ph.D. (January 29, 1998) and Michael Schum, Ph.D. (January 28, 1998) of DTSC's Human and Ecological Risk Division (HERD) detailing our comments and recommendations.

In addition, as we have previously discussed DTSC has reviewed *Parcel A - Phase II Soil Characterization McDonnell Douglas Realty Company C-6 Facility (Report)*, dated July 9, 1997, and has no comments. As DTSC is not the lead agency for this project our review focused on the adequacy of the data for use in the upcoming Health Risk Assessment.

If you have any questions, please call me at (562) 590-4944.

Sincerely,

Karen Baker

Karen Baker, CHG, CEG
Unit Chief
Southern California Permitting Branch

Enclosures

cc: see next page

cc: Mr. Jim Ross
Regional Water Quality Control Board
Los Angeles Region
101 Centre Plaza Drive
Monterey Park, California 91754-7500

Mr. Hugh Marley
Regional Water Quality Control Board
Los Angeles Region
101 Centre Plaza Drive
Monterey Park, California 91754-7500

Ms. Deborah Oudiz, Ph.D.
Department of Toxic Substances Control
Human and Ecological Risk Division
P.O. Box 806
Sacramento, California 95812-0806

Cal/EPA

Department of
Toxic Substances
Control

400 P Street,
4th Floor
P.O. Box 806
Sacramento, CA
95812-0806

MEMORANDUM

Pete Wilson
Governor

James M. Strock
Secretary for
Environmental
Protection

TO: Karen Baker
Hazardous Waste Management Branch
Southern California Region
245 West Broadway, Suite 425
Long Beach, CA 90802

FROM: Deborah Oudiz, Ph.D.
Senior Toxicologist
Human and Ecological Risk Division

DATE: January 29, 1998

SUBJECT: McDonnell Douglas: Response to comments on Health Based Remediation Goals
PCA 24120 Site Code 400627/50 MPC 44

The Human and Ecological Risk Division was requested by you to review the response to comments which was submitted by Integrated Environmental Services (IES) for McDonnell Douglas. HERD has previously reviewed the "Health Based Remediation Goals for Surface Soils, McDonnell Douglas Realty Company C-6 Facility, Parcel A, Los Angeles, California, August 1997" and sent comments to you on November 3, 1997 detailing our concerns. We have subsequently met with you, IES and McDonnell Douglas, and the Los Angeles Regional Water Quality Control Board (LARWQCB) on November 4, 1997 and by phone on November 17, 1997. The current document is in response to the November 3, 1997 review of the health based remediaton goals (HBRG).

Document Reviewed

"Response to Comments in Memorandum Dated November 3, 1997 from the Cal/EPA Department of Toxic Substances Control Regarding Health-Based Remediation Goals for Surface Soils McDonnell Douglas Realty Company C-6 Facility, Parcel A, Los Angeles, California" dated November 25, 1997. Transmitted in a letter dated December 4, 1997 from Mario Stavale, Project Manager, Boeing.

General Comments

In discussions with IES since the receipt of the Response to Comments, it has been indicated that McDonnell Douglas will be retracting the document and using McDonnell Douglas' own internal criteria for the initial round of remedial excavation. While HERD/DTSC does not necessarily condone this approach, we will defer to the lead agency, LARWQCB, for any decisions regarding the remediation of the site. While HERD has not received written confirmation of this decision, we are reviewing the Response to Comments in anticipation of the same principles being used in the post-demolition risk assessment, as requested by IES.

The Response to Comments included a detailed comparative analysis of two indoor air models, the Johnson-Ettinger Model and the Daugherty Model. HERD toxicologist, Dr. Michael Schum, has completed an extensive review of this section in the Response to Comments and sent his comments to you in a memorandum dated January 28, 1998. This current memorandum addresses the remaining comments.

Specific Comments

Comments 1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 16, 17: The responses are acceptable to HERD.

Comment 2 and 4: HERD generally requires a direct contact industrial scenario using parameters included in the Supplemental Guidance for Human Health Multimedia Risk Assessments (July 1992). The inclusion of an industrial worker scenario is required unless the deed restriction includes a contingency for maintenance of a cap. The construction worker scenario can be modified to 126 days per year to reflect an intrusive maintenance worker scenario. It is appropriate in this case to include clean soils which are currently in place for the purposes of calculating exposure point concentrations.

Comments 3 and 14: HERD defers the acceptability of this response to DTSC geologists.

Comment 15: This comment and analysis were reviewed by Dr. Michael Schum in his January 28, 1998 memorandum.

Reviewed by: A. Kimiko Klein, Ph.D. Kimiko K
Staff Toxicologist
Human and Ecological Risk Division

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY PETE WILSON, Governor

DEPARTMENT OF TOXIC SUBSTANCES CONTROL
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MEMORANDUM

TO: Karen Baker
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FROM: Michael Schum, Ph.D. Michael Schum
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DATE: January 28, 1998

SUBJECT: McDonnell-Douglas, Torrence
Review of Air Models to Support Development of Risk-Based Cleanup
PCA: 24120 Site: 400627-50 MPC: 44

Background

Per your Technical Services Request, dated 12/3/97, the Human and Ecological Risk Division (HERD) has reviewed material submitted by Integrated Environmental Services to justify the air emission and modeling approach used to develop health-based remediation goals for surface soil at the McDonnell Douglas Realty Company C-6 Facility, Parcel A. This material was submitted based on comments HERD provided in our review memo dated November 3, 1997. Other issues to which responses have been provided are being addressed separately by Deborah Oudiz, DTSC/HERD.

Document Reviewed

HERD received the following document for review:

Integrated Environmental Services, Inc. Response to Comments November 25, 1997. Response 15; Attachment B.

General Comments

As part of their response to comments of our review memo, Integrated Environmental Services (IES) has provided a comparison of their proposed methodology which was used to estimate air emissions from subsurface soil to indoor air for the McDonnell Douglas site. IES used a screening level model developed by Daugherty (Orange County Environmental Health Department, 1991), and which is compared with our recommended and preferred model generally referred to as the Johnson-Ettinger model (J-E). For reasons discussed below, we feel that the comparison provided is not sufficient to justify the use of the Daugherty model rather than the generally accepted Johnson-Ettinger modeling approach. This conclusion is based both on technical and general policy considerations.

When we recommended the use of the Johnson-Ettinger model for risk assessment of the subsurface soil to indoor air exposure pathway, our intent was that IES would use the equations presented in the U. S. EPA Indoor Air guidance document, one of a number of documents prepared by the EPA Office of Air Quality Planning and Standards, National Technical Guidance Series (NTGS) for Superfund. The primary reason for this recommendation is that the Johnson-Ettinger approach is the only widely accepted, scientifically peer-reviewed model which incorporates both diffusion and pressure driven convective flux of subsurface VOCs to enclosed spaces (indoor air). IES has chosen instead to use a variation of this model proposed in the original paper by Johnson and Ettinger (ES&T, 1991) which considers only diffusion as a transport phenomena. Their justification for using this particular form of the reduced J-E equations is based on assumptions and conclusions with which we do not agree. Their justification essentially boils down to a claim that pressure-driven intrusion of VOCs resulting from building underpressurization is not significant, and that in this case, results obtained using the reduced J-E equation are comparable to the results from the Daugherty Model. However, their arguments that convective flux of VOCs to indoor air can be ignored are not sufficient.

Also, their statement that the pressure-driven models only apply to enclosed spaces in basements is not valid. The equations and graphs to which IES refer in their comparison based on the original J-E paper uses a basement as an <u>example</u> application of the modeling method. There is no a priori assumption required that only air concentrations in basements can be modeled with this approach. Depending on suitable choice of parameters, the model is readily adapted to concrete foundations in direct contact with surface soil (referred to as "above grade by IES), and has been modified accordingly in the newest version of the ASTM RBCA model which has been approved by the ASTM committee 50.04 and is expected to be publicly available within the next few weeks. The official publication will be available through the ASTM Internet Web site at *http://www.astm.org* under the Actions of Committees on Standards.

Policy Issues

Risk assessments submitted to DTSC over the last several years have differed widely in approaches used to estimate the movement of volatile organic chemicals in both groundwater and/or subsurface vadose zone soils to outdoor and indoor air. Most have relied on some variation of Fick's First Law of Diffusion to relate the movement of chemicals proportional to a concentration gradient. While DTSC has accepted many of these risk assessments, it has become increasingly apparent that CalEPA needs consistent, statewide guidelines on preferred models used to evaluate this exposure pathway. The CalEPA Risk Assessment Advisory Committee was formed specifically to address these types of issues. In committee meetings attended by DTSC staff, it was made very clear that emissions models which consider only diffusion to indoor air were inadequate. The scientific panel specifically noted that convective flux models need to be considered. To achieve this risk harmonization within CalEPA, we are now asking that risk assessments submitted to DTSC specifically evaluate this additional component, i.e. the incremental exposure which may result from movement of subsurface VOCs to indoor air by pressure-driven flows as well as diffusion.

There is a consistent regulatory use of the Johnson-Ettinger modeling approach. For example, this approach was used to develop the attenuation factor used in the DTSC CalTox^{tm} model for the intercompartment transfer attenuation factor between vadose zone soil and indoor residential air. The Johnson-Ettinger models are recommended in the following peer-reviewed risk assessment guidance documents:

1. The American Society of Testing Materials Standard #ES1739-95. Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites. November 1995. (RBCA I).

2. The American Society of Testing Materials Subcommittee E40.04, Regulatory Programs, Voluntary Cleanup Task Group. Guide for Risk Based Corrective Action. Draft 8/97. Approved for publication by the ASTM Committee on Standards; expected date of publication early 1998. (RBCA II).

3. Environmental Protection Agency, Office of Air Quality Planning and Standards, Air/Superfund National Technical Guidance Study Series. Assessing Potential Indoor Air Impacts for Superfund Sites. EPA-451/R-92-001. September 1992.

4. Oakland Urban Land Redevelopment Program. Tier 1: Risk-Based Screening Levels. City of Oakland Environmental Services Division. Draft submitted to DTSC Northern California Site Mitigation Branch April 12, 1997; reviewed by HERD 12/17/97.

5. State of Massachusetts, Department of Environmental Protection, Office of Research and Standards.

We are well aware of the numerous and vocal criticisms raised by the regulated community and the environmental consulting firms that the Johnson-Ettinger modeling approach to estimating indoor air concentrations from subsurface VOC sampling data is too conservative. Unfortunately there is little in the way of peer-reviewed scientific literature to unequivocally support these claims. In our discussions with the Massachusetts Department of Environmental Quality, they have indicated that their current efforts to validate these models tentatively shows that while the models may overestimate indoor air concentration for petroleum hydrocarbon products, the models may underestimate concentrations of chlorinated solvents. Until additional validation studies are done, it is our opinion that DTSC should continue to use the Johnson-Ettinger modeling approach which incorporate both diffusion and convective flow terms, and not rely solely on models which consider only diffusion of VOCs into indoor air.

Technical Issues

1. Diffusion-only models vs. diffusion + pressure-driven convective flow models.

We are unwilling to approve any model for movement of VOCs in soil to indoor air which does not explicitly address the potential for chemicals to move both in response to a diffusion gradient <u>and</u> pressure differentials. The scientific basis for this closely coupled transport is defined in the Navier-Stokes equations and can be found in any engineering textbook. The solution to these partial differential equations can only be defined by stipulating the boundary conditions for the equations. The seminal paper by Johnson and Ettinger discusses these boundary conditions to predict their model behavior. Although the prevailing scientific opinion is that diffusion is likely to be the dominant mechanism under most environmental conditions, the rationale proposed by IES for not considering pressure-driven flux is not entirely accurate and is easily misinterpreted. The original paper by J-E indicates that pressure-driven flow can only be ignored under different conditions than those presented by IES. Specifically, a reduced form of the J-E proposed transport equations (and the one presented in the comparison by IES) which considers only diffusion is valid if and only if the following relationship holds:

$(Q_{soil}/L_{crack})\ /\ D^{crack}/A_{crack} = 0$ (see original paper for definition of terms) (1)

The Q_{soil} term in particular combines both a pressure differential term between soil and enclosed spaces and soil permeability.

Rather than use this relationship to decide which functional form of the J-E models should be used as a basis for comparison, IES have used the discussion of simulation results of an example presented in the J-E paper to dismiss inclusion of a convective flux term for their comparison. Specifically, IES has claimed that as long as soil permeability (used in the estimation of the Q_{soil} convective flux term) is less than 1 x 10^{-8} (darcy or cm^2), that no convective term is necessary. We disagree with this conclusion. We also note that the new ASTM RBCA standard (1998, in press) specifically evaluates relationship (1), and lists separate equations to be used for both the groundwater->soil->enclosed space, as well as the subsurface soil->enclosed space exposure pathways when $Q_{soil} > 0$. Our examination of this evaluation indicates that Q_{soil} will be greater than 0 when one uses the new ASTM default building parameters for an industrial use scenario (default values from Table X3.2), and that convective flux should be considered. The 10^{-8} permeability criteria was developed only for a hypothetical residential basement as used in the J-E example. We agree that under highly impermeability soils, VOCs are not likely to migrate to any significant degree when the diffusion distance is great, but we do not necessarily agree that the criteria proposed by IES is a necessary and sufficient condition for dismissing convective flow.

Another more general way to consider if convective flow may be important identified by Johnson and Ettinger uses a metric referred to as the Peclet number. As they note, when this Peclet is significantly larger than one, convective transport dominates and when the Peclet number is significantly less than one, diffusion will dominate. For comparison, silt has a Peclet number of about 0.08; silty sand ranges from 0.08-0.8; fine sand ranges from 0.8 to 8; and medium sand ranges from 8-80. The range of values are directly related to soil moisture content. IES reports that "soils in the upper 20 feet of the C-6 site range from silty sands to dense clays," and we therefore conclude that both diffusion and convection may be important depending on the underlying soils.

2. Soil permeability.

It is well established that soil permeability is one of the most critical parameters in any vadose zone model for movement of volatile organic chemicals to either outdoor or indoor air. It is also difficult to measure soil permeability to vapors directly, and reported values are generally derived from other soil properties. Densely compacted clay soils are certainly expected to provide greater resistance to VOC flux than sandy soils. In addition, vapor permeability is very heavily dependent on water content. This is certainly one of the most highly variable terms in the modeling exercise and may vary by as much as three orders of magnitude even in areas as small as a residential lot.

IES indicates that soil permeability in the McDonnell-Douglas site range from 10^{-9} to 10^{-12}. These values might be expected for dense clays, but higher values would be expected for the silty sands described above. In addition, it is not clear if these permeability values apply to existing, undisturbed soils (we think it probably does), or if it is meant to apply to fill material placed over areas of excavation. We would expect fill material to be substantially more permeable than the native uplifted marine terrace geology in the area, since typical fill material is generally sand and gravel with permeabilities greater than 10^{-5}. The modeling exercise used by IES uses a depth to contamination of ~ 10'. If this depth was determined under the assumption that clean fill would be placed on top of VOC contaminated soil, the permeability assumption used to dismiss convective flux is even further tarnished. This assumption should be critically evaluated anytime the subsurface soil to indoor air pathway drives a risk management cleanup decision.

<u>3. Area of infiltration assumptions.</u>

One of the key assumptions in both types of models is the amount of exposed area in slabs, foundations, basement walls, etc. through which VOCs can move with little resistance, typically with the additional assumption that VOCs do not penetrate significantly though concrete pores (concrete is actually somewhat porous). These VOC vents arise from a variety of sources including, but not limited to, expansion cracks required for concrete and masonry work, between walls and foundations, through plumbing locations in foundations, etc. Contrary to the claim made by IES (p. B7), the USEPA Indoor Air guidance document specifically recommends that screening level assessments assume that all of the building surface area be considered the area of emissions for screening level emission modeling purposes (p. 2-4, 2-6, A-19). This same document also notes that there is insufficient data in the scientific literature to support any particular crack infiltration area expressed as a percentage of the total area (p. A-19). Appendix A in this same document does discuss the use of the Johnson-Ettinger model and uses the <u>example</u> given in the original Johnson-Ettinger paper (1991) on its application. In that example, a 1% area of infiltration was used, but it is not specifically recommended that this value be used by the U. S. EPA. The 1% value is, however, the recommended default value used in both RBCA I and II, so there is some precedent for this value. It should be noted that currently there are no buildings on-site, and that assumptions regarding buildings for a future use scenario cannot be substantiated at this time, i.e. there are no "site-specific" assumptions that can be made about such parameters as VOC infiltration rates or number of air exchanges per hour.

The infiltration area value would need to be evaluated on a case by case basis depending on current and potential land use, building construction design and building codes. For example, many localities require that certain types of new construction incorporate a vapor barrier lining in the foundation which would nearly eliminate intrusion of vapors into indoor air (we question if it is even technically possible to totally eliminate the intrusion of subsurface VOCs with very high diffusivities such as vinyl chloride). By comparison, IES have applied a 0.05% crack infiltration area claiming that higher values are "unreasonable". The evidence they provide to support this claim ("a 1 cm crack, running the length of the building, every 55 cm") fails to consider all potential areas of infiltration that are not simply visible cracks in concrete foundation expansion joints. Since there are no buildings currently on-site, the default value of 1% should be used to develop risk-based remediation levels.

Specific Recommendations

1. Use the Johnson-Ettinger modeling approach as described in the new ASTM guidance document developed specifically for voluntary site cleanup programs at a minimum. IES can provide results using both modeling approaches if desired for risk management purposes. We are including the section from the new ASTM guidance which shows the equations to be used and default assumptions where validated site-specific information cannot be provided.

2. Validate their model results with a) flux chamber measurements of surface emission rates where depth to contamination and soil permeability are known with reasonable certainty, and b) direct measurements of the attenuation coefficient between soil gas directly under a building and indoor air concentration.

Risk Management Considerations

1. The recommended use of the ASTM RBCA equations is guidance only. It is not legally required or enforceable.

2. Either model is still very conservative, but lack sufficient validation to determine degree of conservatism.

3. If the indoor air pathway is a risk driver, direct measurements of indoor air concentrations should be used.

4. Highly uncertain fate and transport modeling should be viewed very cautiously in any final risk management decisions, and even more so in back calculating any risk-based soil remediation levels where the modeling assumptions become even more dubious.

Summary

HERD has appreciated the opportunity to review the report. The comments we have provided are meant to be constructive and we hope they are useful. If you have any questions please call HERD at 327-2498 (Dr. Schum) or 327-2500 for the Human and Ecological Risk Division.

Reviewed by: Deborah Oudiz, Ph.D.
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cc: Stephen DiZio, Ph.D.
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